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AGRICULTURAL DEVELOPMENT.

In the present number of the TROPICAL AGRICULTURIST are reproduced sections of Sessional Paper VI of 1921 relating to scientific research and investigation in regard to the agricultural industries of the colony. It is thought that these sections will be of interest to our readers, as they indicate the efforts which are being made to provide for agricultural development.

The provision of agricultural departments throughout the Empire has been a recent growth, and in no part of it have these departments been fully developed. They are still in their infancy and the Ceylon Department has to progress very considerably before it can be felt that agriculture is being adequately provided for.

The object of an agricultural department must be to place at the disposal of the agriculturist every new development that can be discovered by research, to protect the agricultural industries from epidemics of pests and diseases, to assist in the agricultural and rural education of the population and to assist in the organization of the agricultural industries as business undertakings.

The first in order of importance is the work of research, the second education. Without research, progress will not be possible. The agriculturist, especially in a tropical country dependent upon agriculture for its prosperity, is entitled to receive from the State the latest and best information regarding the developments of science in respect to agriculture.

This research demands properly equipped laboratories and adequate Experiment Stations The initial expenditure to some appears to be considerable, but it is expenditure that has proved to be remunerative. It is expenditure that no country which wishes to progress and develop can afford to neglect.

In all countries, the strengthening of agricultural departments is taking place and in tropical countries capable of development,

the additional provision being made for scientific assistance to the agricultural industries is being greatly augmented.

The work before Ceylon has been indicated and the requirements for the accomplishment of this work shown. The financial aspects of the proposals have been considered in detail.

A beginning has been made with the building of laboratories. One will shortly be completed and a second is projected for the forthcoming year. These laboratories should be completed with as little delay as possible.

The demands upon the scientific staff of the department are yearly increasing. This indicates that their work is becoming recognised by the agricultural community and that they can be looked upon for sound information and advice.

This advice must be based upon facts elicited by investigation and research, and provision must be made for the workers to acquire this information.

The development of the agricultural side of the work in Ceylon requires to be very considerably strengthened, and the provision of a greater number of experiment stations is essential. The climatic conditions make it necessary that experiment stations be established for various areas. The diversity of crops also makes it essential that the field experimental work should not be concentrated in one area.

The recommendation of the Ceylon Committee may be quoted :—"This Committee entirely concurs in the views that 'the establishment of the well-staffed and equipped research station at Peradeniya with branches in the Provinces for the control of investigation, experiment, and development work advocated by the Director of Agriculture, should be proceeded with without delay.' They are satisfied that the present facilities for research are inadequate, and they are confident that increased expenditure under this head is a sound business proposition. Relatively to the enormous sum represented by the total value of the agricultural industries and to the practical dependence, either directly or indirectly, of almost the whole revenue of the State upon these industries, the sum hitherto expended from revenue on agricultural research is really very small."

In conclusion it is only necessary to quote from an official report relating to agricultural research and education in the United Kingdom. It is stated *inter alia* "The present generation would indeed be surprised if they could foresee what science and brains will do for agriculture in the next half century." This statement cannot be contraverted and it is our duty to provide for that research upon which education alone can be based and to so arrange our educational system that all agriculturists in the colony will have an opportunity of profiting by that research.

RUBBER.

THE SELECTIVE CULTIVATION OF RUBBER.

A PAPER BY DR. A. A. L. RUTGERS AT THE INTERNATIONAL RUBBER CONFERENCE.

The first paper read at the conference in connection with the Rubber Exhibition was entitled "THE SELECTIVE CULTIVATION OF RUBBER," by DR. A. A. L. RUTGERS, Director of the General Experimental Station of the A.V.R.O.S., at Medan, Sumatra.

DR. TORREY, opening the proceedings, regretted that nothing had come through from the Mycologists, from whom they had hoped to have a contribution. There was also the usual regret that those engaged in the rubber business were so conservative and secretive. It was very difficult to get their manufacturing friends to come forward and discuss the various technical problems which they encountered in converting crude rubber into the various articles of manufacture which they supplied. But those were things about which it did not pay to be impatient. In the course of time the rubber business would realise the benefit of open discussion, just as the steel trade had realised the benefit of a full and free discussion of their difficulties.

DR. RUTGERS not being present, the paper was read by DR. O. DE VRIES as follows :—

The selecting cultivation of rubber has been neglected for a long time, and even now the majority of planters show little interest in it. The technical advisers of the rubber industry have more than once insisted upon the urgency of research work in this direction, but up to now we find only plans and schemes for such work published in the tropical agricultural press, while results of actual work are lacking. In the Netherlands East Indies, however, since the Rubber Congress, at Batavia in 1914, a good deal of work has been done and some practical results have been recorded.

In Java DR. CRAMER has been importing seeds of different Hevea species for future breeding and hybridization experiments : and, at the same time, the well-known planters, HAMAKER and BODDE, have undertaken practical work on their estates. HAMAKER specialised in seed selection and selective thinning ; while BODDE worked more on vegetative propagation by budding. Both started from the fact that a rubber plantation consists of a majority of low-yielding and a few high-yielding trees. Obviously these high yielders should become the parent-trees for selective cultivation.

The General Experiment Station of the A.V.R.O.S. (General Association of Rubber Planters on East Coast of Sumatra) was opened in January, 1917. From the beginning the selective cultivation of rubber has been one of the most prominent subjects on its programme. Since 1918 a special botanist, DR. HEUSSER, has devoted all his time to this kind of work.

It was clearly recognised at the start that the selection must be worked along two lines. In the first place seed selection, which should result in the

production of a more highly productive variety of tree, which in turn could be propagated by seed, but the difficulty with this method is that so much time is required. It will probably be two or three generations before a constant form that breeds true will be isolated, and companies opening new areas want seeds here and now. Therefore the second method, propagation by budding, has been followed at the same time. If it is found that the superior qualities of high yielding trees remain intact after budding their scions on seedlings, this method makes it possible to plant at once large areas with descendants of the best trees of our present plantations.

EXPERIMENTS AND RECORDS.

Experimental methods have been worked out on both these lines. The fundamental problem in both cases was to make sure which trees are the best ones on each estate. To this end crop records have been taken from many of the best trees on a number of the older estates on the East Coast of Sumatra, the records of some of these trees reaching back as far as 1916. The Experimental Station sends pedigree books and measuring glasses to such estates as desire to keep their parent-trees under regular observation. The very best trees are entered in the pedigree book of the Experiment Station and used for the breeding experiments.

The work done up to now, by the Experiment Station and by the planters on the East Coast of Sumatra, may be summarised as follows :—

Several thousands of valuable parent-trees have been under observation for at least two years. In some cases small areas in new clearings have been planted with seeds of individual mother-trees, the seeds of each mother-tree being kept separate. On other estates the parent-trees have been used for making buddings in the nurseries, and in 1920-21 hundreds of acres are being planted with budded stumps.

The Experimental Station has been using some of the best mother-trees for starting seed gardens. In 20 different places, far away from existing rubber plantations, small seed gardens have been planted, each with buddings from two different parent-trees. It seemed necessary to use two different parent-trees for each seed garden, as self-fertilisation is very seldom encountered in Hevea trees. Some of the seeds from these seed gardens will be selected for a second generation, while the bulk of it will be available for such estates as may be planting new clearings.

Vegetative propagation by buddings is expected to give results almost immediately. Seed selection, on the other hand, is a slower process, but promises to reach a higher standard at the end, and therefore a good deal of work has been spent in this line of investigation. Artificial cross fertilisations and self-fertilisations have been made on a large scale. The difficulty is that the flowers are high up in the tree and not easy to reach. Still DR. HEUSSER succeeded during the last season in making about 8,000 artificial fertilisations, which yielded a little over 2,000 seeds. Twenty different parent-trees were used, and 35 combinations of these 20 trees. In five cases self-fertilisation proved to be impossible, and in one case only 28 seeds were obtained. The seedlings of these 35 combinations will be planted separately, and the next step (after five years) will be to select the best trees from the best combination, as parent-trees for a further selection.

BASIS OF THE WORK.

The basis of this work is wholly a theoretical one. Propagation of the highest yielders by seed and by buddings is advocated, because everywhere else in the world these methods have been a success in agricultural work. Whether the same will be found to hold true in case of rubber, and to what extent production can be increased by selection, nobody can say at present. The general opinion, however, is that in some way or other a considerable increase of the crop can be brought about by selection. Actual figures of the results attained by either of the methods mentioned are either scarce or altogether lacking,

The first areas planted with buddings are only three years old. Tapping results are to be expected in 1921. It is expected that these results will confirm the theoretical point of view, and show the superiority of budded Hevea trees. It is, of course, possible, however, that the influence of the root system is such a dominating factor that budding has no effect at all. Should this be the case the next thing to be tried will be marcotting the buddings before planting in order to develop a root system tracing its origin from the same superior parent-tree. Experiments in this direction met with a complete success, and small experimental areas have been planted to show the influence of the root system on the production of latex.

As to seed selection, figures are already to hand which show the beneficial effect of work in this direction. HAMAKER published some figures relating to his selected seed garden ; HOLLE published figures on the tapping of BODDE'S selected seed gardens ; and DR. HEUSSER, of the General Experimental Station of the A.V.R.O.S., will publish shortly figures obtained from the selected seed-gardens on Byawak Estate. The results are the same everywhere ; the production is higher than could be expected from trees of the same age grown from seeds taken at random. The five-year-old trees at Byawak attained an average daily production of 10·5 grammes.

It will be seen that these investigations, as initiated and undertaken in Java and Sumatra, are only in their infancy, but results obtained up till now show that even in the first generation seed the selective cultivation of rubber trees leads to higher production. This result is the more important because in the cases described, only the mother-tree was a high yielder, while the pollen was of unknown origin. Surely better results are to be expected when both parent-trees are high yielders, as was the case in the artificial fertilisation which were carried out. No one can say at this moment what results will be reached in this way when selection has been continued for several generations. It seems not extravagant to predict results similar to those obtained in Java on cinchona trees, where the planters doubled the production from the individual trees by careful and continuous selection.—

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THE MIXED CULTIVATION OF HEVEA AND ROBUSTA COFFEE.*

During the year 1906 the well-known Besoeki planter, MR. DAVID BIRNIE, took the initiative in constructing mixed plantations of Hevea and Robusta coffee at Bajoe Kidoel Estate, Banjoewangi.

At that time both cultivations were still in their infancy, and the future for either one was uncertain. In order to decrease the risk by 50 per cent.

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* A paper by DR. A. J. ULTEE (Director of the Besoeki Experiment Station, Djember, Java), delivered at the International Rubber Conference.

the Hevea gardens were interplanted with Robusta. It soon became clear that the advantages were far in excess of the disadvantages, and the example thus set was immediately followed by other planters. In the beginning many a board of directors did not favour the new system, but for the last ten years it has been the rule in East Java to cultivate Hevea with Robusta interplanted. At the present time not an expert would think of omitting Robusta in a new clearing for rubber cultivation.

Especially during and after the war it has been proved how important it is for an estate not to be dependent on one product. There was a time when coffee could hardly be sold at all, but the estates still had their income from rubber. Just now the rubber market is very poor, so that many estates cannot make profits, but even though the price of coffee is not high either, it is worth while cultivating it.

There are several reasons why this system is hardly found outside of East Java, and is not being followed in other rubber-growing districts. Owing to the favourable climate, but especially to the good soil, East Java has always ranked among the first coffee districts. The soil is of recent volcanic formation, is easily penetrated by the air, and not heavy, which is favourable for the proper development of coffee. When the cultivation of rubber was adopted, many Java coffee estates were in existence, but they were not in a very flourishing condition, owing to the fatal leaf disease. Consequently coffee factories with the necessary mechanical power and equipment were available, and the managers were expert with the cultivation of coffee. When therefore it became evident that coffee and Hevea were an excellent combination, the planters planted the new clearing with both.

In other rubber districts coffee cultivation has never been of very much importance. The soil is heavier and less friable, so that Robusta can never be as profitable as in East Java. It is probable, moreover, that Hevea develops more rapidly in heavy soil, with the result that the dense shadow of the trees impairs the coffee crops after a short period of production. These facts, coupled with the lack of expert managers, explain the absence of mixed plantations outside of East Java.

It has been asked, why, on a 2,000 acre estate, the owners do not plant 1,000 acres rubber and 1,000 acres Robusta separately, instead of a mixed plantation of 2,000 acres. At first thought one would say that this method is better, because one can give each plantation exactly what is necessary for proper development, while in a mixed plantation one crop may interfere with the other in the long run. In a separated plantation, however, the decrease of risk is much less. In case either Robusta or Hevea proved to be a failure, 1,000 acres would have to be written off, but in a mixed plantation the entire area would be preserved by cutting out the trees of the product to be disposed of. Now it has been proved clearly that in East Java Hevea and Robusta are both profitable crops, and yet a planter will start with a mixed plantation when clearing for a new estate, for nobody can tell how the conditions as to coffee will be in years to come. In the Netherlands West Indies a leaf disease ruined Hevea in a few years, and in the East Indies a little beetle that penetrates the fruit is a menace to the Robusta.

However, decrease of risk is not the only point in favour of a mixed plantation. Hevea is planted thinly so that during the first years there is the probability of a decreased fertility, partly due to the showers that wash away the upper soil, and also to the intense sunshine, which burns the humus-

When the interplanting system is followed, however, the soil is soon shielded from intense direct sunlight, while the densely growing hair-roots of the Robusta prevents the soil being washed away.

A third important advantage of a mixed plantation must be noted. If only Hevea were planted, one would have to wait five years before the first crop would come in, because in East Java the greater part of the estates are situated on the slopes of the mountains and not in the low plains. A catch crop like Robusta gives good harvests after three years, so that revenue comes in sooner. Many estates would have had to clear less quickly, and would have paid dividends much later if they had not had their Robusta crops.

And now having stated the advantages, we must also state the disadvantages. In the first place it is harder to find managers who are expert in both cultivations, and who will take proper care of the estates Furthermore, the coffee will always act as a slight obstacle to the development of Hevea, so that the latter will come to the tapping stage a little later. When the rubber trees are in bearing, there is more danger of a disease like stripey canker than would be the case in a pure Hevea plantation.

These disadvantages are not very weighty, however, in view of the advantages to be stated presently, but we must say something about the practical advantages of combining Robusta with Hevea. One cannot expect a uniform working plan for all estates, on account of the difference in climate, altitude and formation of the soil.

In 1906 MR. DAVID BIRNIE chose a dense planting configuration for the coffee, namely 6 feet by 6 feet, in order to obtain soon a closed plantation, which makes the upkeep easier (less weeding and less labour) and also in order to obtain large crops in the first years. The Heveas were planted 12 feet by 24 feet, where the Robusta would be if the plantations were not mixed. At the same time the young coffee received shadow from a row of *Leucæna glauca*.

It is essential, for a proper control, to cut out the coffee in the rows where the Heveas are 12 feet apart, as soon as the tapping is commenced. Since the Robustas to be cut are of little use, we do not plant them now-a-days when clearing. There is much variation in the planting configuration of the Hevea as well as of the Robusta. Some planters think 6 feet by 6 feet too dense a configuration, and prefer 7 feet by 7 feet, even 8 feet by 8 feet, giving the Hevea distance of e.g., 21 feet by 21 feet or 16 feet by 24 feet, etc.

Of course there is still more variation in the case of an older plantation. Naturally everybody cuts out the rows of shade trees, because the Heveas take over their duties. Local circumstances and the market value of coffee and rubber determine how the plantation shall be treated later on. An estate at low altitude, where Hevea grows very well, as a rule gradually cuts out its Robusta, keeping a pure rubber plantation. Estates situated at a greater altitude will save their coffee as long as can be, and cut the poorest Heveas. Undoubtedly the safest way is to assign part of the estate exclusively to Hevea, and gradually cut out all the Robusta, and keep the rest of the estate as mixed plantation with coffee as principal cultivation, so that it does not suffer from the Hevea that is being retained.

It must be granted that it is not an altogether simple matter to act according to these rules, and the decision has been put off on more than one estate until it was too late.

In closing this presentation of the advantages of mixed plantation of Hevea and coffee, we shall give a statement taken from practice showing the results obtained from an experimental plantation of two "bouws." The Robusta is planted 6 feet by 6 feet, the Hevea 12 feet by 22 feet. The

coffee crops were as follows :--

During the 3rd year per acre	...	22·8 picol.
During the 4th year per acre	...	21·7 ,,
During the 5th year per acre	...	20·0 ,,
During the 6th year per acre	...	10·3 ,,
During the 7th year per acre	...	9·4 ,,
During the 8th year per acre	...	13·1 ,,
During the 9th year per acre	...	6·8 ,,
During the 10th year per acre	...	3·2 ,,

When all the Robusta had been cut, 10 years after planting, they had produced 107·3 picol per acre. This is abnormally high, and can only be obtained with very favourable weather, and in an experimental garden, where every care can be taken.

Therefore the following stating the results of a plantation of 38 "bouws" have more value.

The coffee was planted 8 feet by 8 feet, and produced :—

During the 3rd year per acre	...	17·4 picol.
During the 4th year per acre	...	8·6 ,,
During the 5th year per acre	...	13·1 ,,
During the 6th year per acre	...	6·8 ,,
During the 7th year per acre	...	3·2 ,,
During the 8th year per acre	...	3·0 ,,

The following data were obtained from an estate, started in 1907, and possessing mixed plantations, as mentioned below :—

107½ Bouw plantation of	...	...	1907
62½ Bouw plantation of	...	...	1908
50¾ Bouw plantation of	...	...	1909
286½ Bouw plantation of	...	...	1910
295½ Bouw plantation of	...	...	1911
60¼ Bouw plantation of	...	...	1912
863 Bouw Total			

Before the Hevea was ready for tapping, the profits on coffee crops were :—

				F
In 1910	...	..	...	14,546
In 1911	...	...	...	72,254
In 1912	...	...	...	89,239
In 1913	...	...	..	73,616
			Total	F. 249,655

During the following year the profits were :—

In 1914	...	Coffee	f. 179,115	Rubber	f.	39,068
In 1915	...	,,	f. 176,035	,,	f	106,213
In 1916	...	,,	f. 128,980	,,	f.	282,958
In 1917	...	,,	f. 57,717	,,	f.	288,279
In 1918	...	,,	f. 40,285	,,	f.	100,657
In 1919	...	,,	f. 31,397	,,	f.	379,054
		Total	f. 613,529		f.	1,196,229
		Before 1917	f. 249,655			—
		Total	f. 863,284		f.	1,196,229

1 picol=1·21 cwt. 1 bouw=1¾ acres.

RUBBER YIELD CALCULATIONS.*

N. BOSANQUET.

In the past years the majority of estates have been prepared to accept certain figures of yields as representing normal yields, and provided 400 lb. per acre was secured in a certain district in which 400 lb. was looked upon as the normal for that district, everyone was satisfied, and with a price of from 2*s*. 6*d*. to 3*s*. 6*d*. per lb., and reasonably economical working, the estates concerned showed satisfactory results. In arriving at our figures showing the probable supply of rubber in comparison with the probable consumption during the next few years, I think as a rule a figure of from 300 to 400 lb. per acre is usually taken as a basis for calculation. The present position of the industry is, I suggest, if left to take care of itself, going to produce two considerable changes: first, largely increased yields in the future, and secondly, much reduced costs of production.

YIELDS LIMITED BY BAD INITIAL SYSTEMS OF TAPPING AND PLANTING.

In the past I suggest that several things have been instrumental in helping to keep yields down. First, our original systems of tapping were bad, and the tapping itself bad, while up to quite a recent date the majority of estates have been out after crop in view of the very high prices and a large number of them have been over-tapped in consequence.

Many of these estates are bringing in their rubber young, and tapping it severely on the principle of more cuts more latex, thereby using up an enormous quantity of bark, doing no good to the trees and reducing crop in later years.

Again, our original planting distances—12 by 12, 20 by 10, 15 by 15—were all much too close unless planted with the object of early thinning out.

While it is true that areas so planted produced their 400 lb. per acre with their trees standing 20 by 10, I suggest that had they been brought into regular tapping with a smaller number of trees to the acre the same results could have been secured on a permanent yield in place of a temporary 400 lb. per acre, reduced afterwards by thinning until the trees began to yield normally again after the process, and in many cases more or less permanently reduced yields die to over-crowding.

I suggest that the first 500,000 acres comes under this planting system, and that the 17 by 17 and 24 by 12 planting ran in into at least the first 1,500,000 acres planted. Thinning in many of these areas was undertaken late.

On hill estates little was done to prevent loss of soil.

POTENTIAL YIELDS AND FUTURE OUTPUT.

In spite of all these early mistakes, estates, given reasonable good soil and conditions, have generally averaged 300 to 400 lb. per acre, while, as we know, much larger yields have been secured from many properties without the assistance of manure. In calculating future returns we must, I think,

* In the following striking paper delivered at the International Rubber Conference MR. N. BOSANQUET deals with many interesting points in connection with the rubber yielding capacity of plantations, including the possibility of an unprecedented increase of yield per acre through carefully controlled selective thinning out.

bear in mind that restriction has been resting some of the oldest rubber, which badly needed it, and that much of this rubber which has been giving reduced yields is coming back with better renewed bark and increased vigour and the promise of largely increased yields.

If we take the planted acreage as 3,000,000 acres and the average yield per acre as 300 lb., the annual production figure is going to be 400,000 tons, and every pound per acre increase on that figure will give an annual increase of 1,339 tons, so that should the average yield work out at 400 lb., which I suggest can be the case, the annual output which the industry is going to be asked to face will be something in the region of 530,000 tons.

I suggest that we must always have the figure of 500,000 tons in our minds, because however large an acreage of rubber may disappear from the producing acreage as a result of the present price, it will be ready to come back again when the selling price justifies it in doing so.

ABANDONED ACREAGE CAPABLE OF BEING BROUGHT BACK INTO TAPPING.

We hear so constantly reference made to the "survival of the fittest" in our present difficulties, and many people, I think, imagine that a rubber estate abandoned is abandoned for all time. Let me quote one instance An estate in 1913 had some of its oldest rubber practically in a state of abandonment, at all events some 30 to 40 per cent. of the trees were standing dead of fomes and other diseases, and the 45 acres and 65 acres of rubber, the two areas concerned, were a very questionable asset; the rubber at that time was five and six years old. Disease was tackled, the fields cleared up, and later on supplies put in, and in 1920 these two fields yielded 319 lb. and 358 lb. per acre respectively, with 45 and 54 trees per acre in tapping.

HEAVY YIELDS BY TREE SELECTION.

Now with regard to the possibility of much heavier yields in the future than any we have so far been accustomed to, MR. BANNERMAN has sent us interesting figures as a result of experiments in thinning out, and he finds that tree selection is of such importance that should sufficient attention be paid to tree selection by yield there is no reason apparently why an estate should not succeed in putting out 1,000 lb. per acre. His experiments go to show that provided trees are planted at close distances when clearings are first opened, selection by yield can be made on experimental tapping, and that provided each tree when the clearing eventually carries only 80 trees per acre gives $\frac{1}{4}$ cup of latex—a yield of 676 lb. is secured, $\frac{3}{8}$ cup 1,014 lb., and $\frac{1}{2}$ cup 1,352 lb. Thinning in the past has been done on the principle of taking out the worst looking trees first, and eventually leaving the best looking trees, but as we all know the biggest tree is not necessarily the best yielder, and we have doubtless removed a number of our best yielders in effecting our thinning-out operations. The point I think we must bear in mind is that recently-planted estates can probably work up their yields by judicious planting and eventual thinning-out to anything up to six, seven, or eight hundred pounds per acre, while the older areas, through improved tapping systems and resting old tapped areas can increase their yields from 400 lb. to 500 lb. per acre. In the past trees have been tapped as high as six feet from the ground, not to mention trees which have been tapped above their original surface altogether with the help of a ladder, and the higher we

tapped so did the yield decrease. The chief reason for this high tapping was too rapid bark removal. We now know that $\frac{3}{4}$ in. per month alternate day tapping is a liberal allowance of bark, and that no tree need ever be tapped higher than 39 inches from the ground, allowing three inches for the spout and eight years' bark renewal, and that on virgin bark we can secure yields up to 450 and 500 lb. per acre. All experience goes to show that the lower you can tap the better is the yield, so that it would seem to me that having found out which part of the tree gives the best yield it now remains to decide on the tapping intervals which will be the most economical. Under present conditions we can look forward to a yearly production of 530,000 tons of rubber. Improved methods of thinning and cultivation generally may increase this to 660,000 tons. What would be the effect on the yields and cost prices if in place of present methods of tapping we changed our system to a universal three days' tapping interval? Figures which I have show a decrease in crop tapping every third day over a period of six months of 26 per cent. as compared with alternate-day tapping.

On another estate over a period of one year, a block of 110 acres tapped in 1919 on alternate days was tapped during 1920 every third day, and the field yielded 294 lb. per acre on every third day as compared with 332 lb. per acre on alternate days, or a reduction of about 12 per cent. Simultaneously, with the tapping of this block during 1920, on every third day, a part of the same field, amounting to 80 acres, was tapped alternate days, and the yield works out at 294 lb. every third day, against 331 lb. alternate day or again a difference over a year of about 12 per cent.

Suppose, therefore, that estates tapping alternate day reduce their yields of 25 per cent. by going on to every third day tapping, and those tapping every day reduce 50 per cent, on changing to the same system. If we take the normal 1921 production as being 360,000 tons, and assuming that 50 per cent. is from alternate and 50 per cent. from every day tapping estates, we should show the production reduced as follows :—

180,000 tons by 25 per cent. to 135,000 tons ; and
180,000 tons by 50 per cent. to 90,000 tons ;

thus reducing the production for the next 12 months to 225,000 tons.

ECONOMICAL YIELDS BY LESS FREQUENT TAPPING.

What effect would this change of tapping system have on cost prices f.o.b.? Taking a tapping task as being 240 trees and average trees per acre as 80, the alternate day estate would reduce tappers from one for six acres to one for nine acres, and the daily tapped estate would reduce one tapper for three acres to one for nine acres—thus saving £550 per annum in the first case on cropping expenses and £2,220 in the second case. Besides the saving on cropping expenses tapping one-third of the estates would entail less supervision ; on the reduction in the labour force a consequent reduction in medical expenses ; a reduction in recruiting expenses, buildings, tapping tools, loss on rice. While I suggest that the trees themselves would benefit by a longer tapping interval, and Brown Bast would be encouraged to disappear, I admit that every third day tapping would provide a temporary reduction in crop only, and that in a comparatively short time our yields would from this system begin to equal those now secured from daily and alternate day tapping, but then again could not the remedy be found for any sign of over-production by a further change in the tapping interval.

I would like to suggest that from the time when we first started tapping plantation rubber tapping systems have become less and less drastic; beginning with V cuts all over the tree or spirals and double herring-bones as high as a coolie could reach we changed gradually on to single herring-bone till we have come down to single cuts, and I suggest that improved methods of tapping promise us largely-increased yields in the future provided labour is available, and that the time has come when we should consider reducing the number of days we tap our trees in the same way that we have reduced the number of cuts. We must, too, bear in mind that restriction of output is essential at the present time, and I suggest that the alteration in the tapping interval is the best and cheapest way of securing it.—INDIA-RUBBER JOURNAL, Vol. LXI, No. 26.

INVESTIGATIONS CONCERNING THE ORIGIN OF LATEX OF HEVEA BRASILIENSIS.

Dr. W. BOBILIOFF.

The results obtained from this investigation can be summarized as follows :—

1st. By the changing of colour of the latex from yellow to white in the neighbourhood of the tapping-cut of Hevea trees which possess yellow latex, it is possible to control the extraction sphere of latex when tapped. The appearance of white-coloured latex at places where previously the yellow-coloured was present, indicates that these places are exhausted and that secondary latex-building then takes place here.

2nd. The flow of latex to the tapping-cut is very slow.

3rd. After two and a half months the flow of the latex to the tapping-cut covers a distance of about 1 Meter.

4th. The extracting of latex by ordinary tapping from above downwards occurs only from the latex-vessels which lie underneath the tapping-cut and about 5 Meters on each side of the cortex,

5th. The extraction by tapping from below upwards is slightly less than by the reverse methods.

6th. If the tapping-cut is high above the ground then the latex comes from the trunk only; also when the tree has been tapped for a long period. If the tapping cut is low down on the trunk then the latex is extracted also from the roots, but only from the places lying below the tapping-cut or in the vicinity. In this case the latex is extracted from the side-roots, but only from those under the tapping-cut.

7th. Above the tapping-cut there is no extraction of latex by ordinary tapping.

8th. The above-mentioned facts were proved by tests with three-year-old grafted trees, in the trunk of which was yellow latex, while the understem contained white latex.—ARCHIEF VOOR DE RUBBERCULTUUR, 5e JAARGANG, No. 3.

CEYLON AGRICULTURE.

SCIENTIFIC RESEARCH AND INVESTIGATION IN REGARD TO THE AGRICULTURAL INDUSTRIES OF CEYLON.

The following is a report on "Scientific Research and Investigation in regard to the Agricultural Industries of Ceylon" submitted by the HON'BLE MR. F. A. STOCKDALE, Director of Agriculture.

In drafting a report dealing with the various points indicated in LORD MILNER'S despatch of June 11, in so far as they affect the agricultural industries of Ceylon, reference is invited, in the first instance, to the correspondence noted below :—

Colonial Secretary to Director of Agriculture, 31, of February 12, 1917, etc., having reference to the work of the Committee of the Privy Council for Scientific and Industrial Research.

Director of Agriculture to Colonial Secretary. 137, July 26, 1917 submitting proposal for co-ordination and extension of agricultural services, paragraphs 5 to 14 and paragraphs 50 and 53.

Director of Agriculture to Colonial Secretary, 138, July 26, 1917, submitting estimates in connection with above proposals.

Colonial Secretary to Director of Agriculture, 148, of October 11, 1917, etc., with reference to research in rubber work in connection with diseases of plantation rubber.

Colonial Secretary to Director of Agriculture, 47, of May 28, 1918, etc., having reference to a scheme from the Rubber Growers' Association for the co-ordination of the existing machinery for rubber research in Ceylon and Malaya.

Colonial Secretary to Director of Agriculture, 48, of June 1, 1918, etc., relating to measures for preventing fungal diseases of rubber.

In considering the despatch under reference, it is desirable to have a clear conception of the differences between (1) research, (2) investigation, (3) developmental experimentation, and (4) exploration. There is naturally some overlapping of work capable of being classified under these headings, but the following examples of work conducted in the Colony are illustrative of the accepted differentiations above specified. Research may be divided for convenience into (a) pure research and (b) applied research. While it is certain that "applied science is nothing but the application of pure science to particular classes of problems," it is convenient to recognise when dealing with the business world a difference between pure science and applied science.

In pure research the work carried out by SMITH on the Physiology of Tropical Plants, WILLIS on Mutation and Evolution, LOCK on the Application of MENDEL'S Laws of Heredity to Tropical Subjects, and PETCH on the Fungi Parasitic on Scale Insects are examples on the botanical side.

In research applied to agricultural problems examples are more numerous, but it is only necessary to instance PETCH's works on the various Fungus Diseases of economic plants, GREEN's investigations of Insect Pests affecting the main agricultural crops of the Colony, CAMPBELL's Researches into Rubber problems, LOCK's work on Paddy Breeding and Selection, and BAMBER's Inquiries into the Composition of the Soils of the Colony and into Problems affecting Tea Industry.

Under the heading "Investigation" would be classified the acclimatization work of the botanic gardens, the experimental trial of imported types of crops, and the varietal tests and manurial trials with various crops upon experiment stations, the tapping experiments with rubber, and the inquiries into various cultural methods to be applied to different agricultural crops.

Under "Developmental Experimentation" would be included the trial of economic crops on a sufficiently large scale to make the experiment of direct economic value. The opening of definite plantations of rubber under Government auspices in the early days of rubber in the East can be cited as an example, the present trials with oil palms, limes, and fibres at Anuradhapura Experiment Station, and the trials with coffees at Peradeniya, and with castor cultivation in the Northern and North-Central Provinces are examples of what would be included under this heading.

The re-afforestation of areas with teak, margosa, eucalyptus, conifers, etc., by the Forest Department are further examples.

Under "Exploration" would be grouped those investigations into the flora and fauna of the Colony and into its natural resources. On the botanical side such work was commenced by the investigation of Flora of the Colony by THWAITES, TRIMEN, and WILLIS, and is being continued by the Forest Department in connection with the timbers of the Colony. The work of PETCH on the Fungus Flora of the Colony and of GREEN on its Coccidea would also be classified under this head of Exploration.

THE PAST.

It is unnecessary to examine the work of the past in detail, but it cannot be overlooked that coffee, cinchona, tea, cacao, and rubber are all exotics to Ceylon, and that the Botanical (now Agricultural) Department has played an important part towards the establishment and fostering of these industries. Ceylon has been in the past looked upon as the botanical centre of the Empire's tropical possessions. The first work was carried out in connection with the systematic side of botany and with acclimatization under the guidance of GARDENER, THWAITES, and TRIMEN. Subsequently the economic work demanded greater and closer attention, and has gradually been overtaking the purely systematic work.

The record of work is one of which the Colony and the Empire has just reason to be proud. In the realms of tropical agriculture Ceylon has in the past played the part of the pioneer, and the scientific workers of the Botanical (now Agricultural) Department have equally been pioneers in their work affecting tropical vegetation. The Government of this Colony has, in a measure and as far as its funds permitted, supported the efforts of its scientific officers, and has reason to be satisfied with the work that has been accomplished. This has been due to a whole-hearted devotion to scientific studies by officers who have established for Ceylon a reputation in

the scientific centres of the tropics and of the world. During the past few years, however, there has been a change in the relationship between the State and scientific investigation, and a much more liberal conception of the duties of the State towards scientific research and investigation now prevails.

THE PRESENT.

The tea industry is the most important agricultural industry of the Colony. The work being performed for this industry consists of the following :—

Research.—Insect pests and diseases. The shot-hole borer pest investigations are being continued. This is a difficult problem that will take some time to complete. The tea tortrix pest has been closely investigated during the past two years, and measures for its control worked out and recommended. Fungus diseases are also receiving attention, but more work in this direction is necessary. Regular field inspection work in conjunction with research officers is being arranged for and will begin from the present year.

Investigation.—Manurial experiments are being carried out at Peradeniya Experiment Station on a small scale.

For the *Rubber* industry the following work is being carried on :—

Research.—More than half of the time of the Mycologist is devoted to investigations into the fungus diseases of rubber. More work could be accomplished if additional workers were available, and should be possible on the return of the Assistant Mycologist from war service. The number of specimens of rubber diseases sent in for examination and report is increasing annually, and is not expected to diminish. Inspection of cultivations for pests and diseases in conjunction with Research Officers of the Department of Agriculture is being arranged for. Chemical research into vulcanization processes and with rubbers prepared by different methods has been carried on by the Ceylon Rubber Research Scheme in conjunction with the Imperial Institute in London, and the results of this work have been recently issued in book form entitled "RUBBER RESEARCH IN CEYLON." Researches into the morphology and physiology of the rubber tree and into the physiology of rubber latex were carried out by the Rubber Research Chemist in co-operation with the Assistant Botanist and Mycologist of the Department of Agriculture, but these researches have been suspended since 1917 owing to officers having proceeded on war service. Plans have also been made for research into the heredity of the rubber tree with a view to improvement by seed selection. A number of trees of known parentage will be available for experimental tapping next year.

Investigation.—Tapping experiments have been in operation for a number of years, and are being continued. Manurial experiments are also being carried on, and spacing experiments on a small scale have been arranged. Planting of rubber from known trees has also been made for future investigation work.

Developmental Experimentation.— In the earlier days experimental plantations of rubber were established, but rubber is now growing in most districts of the Colony, and further work of this nature is no longer necessary.

COCONUTS : *Research.*—Very little true research work has been carried on in connection with this industry. A few observations have been made on the botanical side from time to time, but a continued study of the many problems requiring investigation has not been undertaken.

Investigation.—Within recent years manurial and cultural experiments have been carried out at Chilaw, and in co-operation with estates at Negombo and Pitiakande. Experiments on a much larger scale and upon a more scientific basis are required. Some investigations with the insect pests and fungus diseases have been made, but more detailed work is required.

CACAO : *Research* work in connection with insect pests and canker and other diseases of cacao has received close attention, and investigations into control measures made. A critical examination of the varieties of the cacao under cultivation at the Experiment Station and on the Botanic Gardens has been made, and plots for breeding and selection experiments planted out.

Investigation.—Cultural, manurial, and shade investigations have been made, and are being continued in modified form. The plots are irregular, and conclusive results will not be forthcoming from the plots at present under experiment.

COFFEE : *Investigation.*—Varietal tests are being carried out at Peradeniya Experiment Station.

TOBACCO : *Investigation* into the possibilities of tobacco at Maha Iluppalama has been made, and within recent years trials have been carried out with exotic tobaccos at Jaffna, and this year at Teldeniya. At Jaffna it has been demonstrated that White Burley and Turkish types of tobacco suitable for the European market can be grown. There is a possibility of the development of the Teldeniya area and the Dumbara Valley for cigar tobaccos

FIBRES.—Cultivation of Sisal was successful at Maha Iluppalama Experiment Station, and an area sufficiently large enough to warrant the erection of a scrutching machine has recently been planted in Sisal and Mauritius hemp at Anuradhapura Experiment Station.

CASTOR.—Investigations into the possibilities of castor have been made at Madawachchi, Iranamadu, and Madhu Road during the past year. Where sowing was made with the early rains of the north-east monsoon, and when damage from wild animals was not incurred, the results are promising. The demand for castor oil for medicine within the Colony, for lubricating oil, and for the resulting castor cake for manurial purposes on tea and rubber plantations warrants a considerable extension of these experiments.

PADDY : *Research.*—Some work was done by the late DR. LOCK, in the selection and improvement of paddy varieties suited to the higher elevations. With his departure from this Colony, the work was discontinued, but so important is the work that it has been decided to begin work again with the arrival of an Economic Botanist.

Investigation.—Some varietal tests have been made on the Experiment Stations at Peradeniya and Anuradhapura, manurial experiments have also been carried on, and trials made with varieties imported by the Agricultural Society. Co-operative experiments have been conducted by the Agricultural Society with cultivators in regard to cultural and manurial requirements, and the varietal tests have been carried on.

OTHER FOOD CROPS.—Varietal tests with manioc, sweet potatos, yams, legumes, maize, and millets have been undertaken at the Peradeniya and Anuradhapura Experiment Stations recently. More work in this direction is possible.

LIMES: *Investigation.*—An area of limes has been planted at Anuradhapura Experiment Station under irrigation, in order to test the possibilities of this crop for the production of citric acid.

COTTON.—Some seed of Cambodia cotton from South India has been experimented with in Jaffna, and has been distributed in dry areas in the Central and Southern Provinces.

CATTLE.—A dairy of Scind cattle is maintained under the Veterinary Department in Colombo. Many animals bred at this dairy have been sold to various parts of the Colony. A small dairy is to be established at the Peradeniya Agricultural School, and a breeding herd of draught cattle at the Experiment Station.

CARDAMOMS, CINNAMON, CITRONELLA, CAMPHOR.—No work in regard to these is being carried on.

FRUIT.—The raising of nursery stock and the cultivation of small numbers of trees and plants are being carried on.

SUGAR-CANE.—A few varieties are being tested on a small scale at Peradeniya and Anuradhapura Experiment Stations.

REQUIREMENTS OF THE AGRICULTURAL INDUSTRIES.

TEA INDUSTRY: *Research.*—(1) The continuation of the work in regard to pests and diseases is necessary.

(2) The physiology of the tea bush and the effects of plucking and pruning on the bush require to be investigated.

(3) Varietal tests of different jâts and the improvement of the existing types by selection and hybridization require to be undertaken.

(4) A detailed survey of the soils of the tea-growing area and examination from a chemical point of view together with a bacterial investigation into the formation of humus by the green manures largely used now on tea estates, is required.

(5) The effects of climate and other causes on the flavours of tea require further work to be carried on.

(6) The possibilities of the preparation of caffeine from tea fluff require detailed investigation.

Investigation.—(1) Further investigations into the manurial requirements of tea in the different tea-growing areas of the Colony are required.

(2) Investigation as to the possibility of securing local supplies of organic manures from locally grown oil seeds should be continued. The stability of tea depends so largely upon the maintenance of the humus of the soil. Large quantities of organic cakes and poonacs are annually imported from India. The requirements of India are rapidly increasing. The Colony must endeavour to meet its own requirements. Castor, ground nut, and possibly rubber seed cakes are required for the tea industry.

(3) Investigation into the prospects of the local production of nitrogenous manures by utilization of water power now running to waste is required

(4) Fuel is becoming a difficulty in some areas. The possibility of encouraging the increase of fuel production in those tea-growing areas up-country that are short is deserving of the fullest consideration.

(5) Tea chests are largely imported. There would appear to be reasons to believe that these could be produced locally if suitable timbers were planted over large areas. Some testing of timbers has been done, but more appears to be required.

RUBBER INDUSTRY: *Research.*—(1) The continuation of the physiological and chemical investigations into the rubber tree is urgently necessary.

(2) The bio-chemistry of rubber latex and its formation require investigation.

(3) Fungus diseases require more and fuller detailed investigation.

(4) The chemical examination of rubber made by various processes and the vulcanization tests require to be continued. The possibilities of starting rubber manufactures in the Colony are worthy of consideration.

(5) The possible utilization of rubber seed requires to be investigated.

(6) The inheritance of characters and the improvement of rubber trees by selection and plant breeding requires detailed and continuous study.

Investigation.—(1) Control measures against diseases require investigation.

(2) The manurial requirements of rubber need careful experimentation. The present area at Peradeniya is considered to be too small.

(3) The continuation of tapping experiments is desirable.

(4) The possibility of securing local supplies of organic manures for manurial purposes deserves close consideration.

COCONUT INDUSTRY: *Research.*—(1) A botanical examination of the coconut palm, particularly in respect of the fertilization of its flowers, is necessary.

(2) Investigation of varieties and their yielding capacities with a view to improvement by selection and breeding is required.

(3) A biological examination of the moulds of copra and means for their prevention require investigation.

(4) Industrial investigation into the manufacture of copra, desiccated nuts, and oil is desirable. There would appear to be every reason to suppose that the development of the coconut industry in Ceylon will tend towards a much greater local production of coconut oil.

(5) Researches into the life histories of the pests and diseases of the coconut palm.

Investigation.—(1) Into the cultural treatment of the coconut on different soils.

(2) Into the manurial requirements of the coconut on different soils.

(3) Further investigation into the means of controlling pests and diseases of coconuts.

CACAO INDUSTRY: *Research.*—(1) Chemical and biological investigations into the fermentation of cacao. Further work is required, particularly in regard to the formation of the different types of cacao.

(2) The cacao flower and its pollination still require examination.

(3) Improvement of yields by selection and breeding from hardy varieties has yet to be carried out.

Investigation.—(1) The manurial and cultural requirements of cacao.

(2) Possibilities of the preparation of chocolate on a reasonably large scale for Ceylon, India, and other Eastern markets.

COFFEE: *Research.*—Relative resistance of various types of coffee to the leaf disease fungus and the evolution of disease-resisting types with a view to resuscitation of a coffee industry.

(2) The relation of the coffee leaf disease fungus to the native fungi of the same genus. The Empire depends for its coffee very largely upon foreign countries, and the possibility of producing increasing quantities of coffee within the Empire requires investigation.

CINNAMON: *Investigation.*—(1) Manurial experiments are required. The cinnamon area is being reduced by planting with coconuts. The yields of cinnamon per acre must therefore be increased.

(2) The preparation of cinnamon and improved cinnamon oils requires investigation, and the varieties of cinnamon should be gone into.

CARDAMOMS: *Investigation.*—The improvement of yields per acre and of the preparation of this crop requires consideration.

CITRONELLA AND LEMON GRASS OILS:—*Investigation.*—This industry is dwindling, considerable areas under citronella in the Southern Province being now planted with rubber. Improvements in the methods of distillation could be effected.

TOBACCO:—*Investigation.*—The work already begun requires to be continued, especially in the Jaffna and Teldeniya areas.

PADDY INDUSTRY:—*Research.*—(1) Improvement of varieties by selection and cross-breeding is urgently required. This has been demonstrated to have been successful in other countries, and could likewise be carried on with advantage in Ceylon. An Economic Botanist is being secured primarily for this work.

Investigation.—(1) Effects of different manures on the paddy crop in various districts, with varying soil and climatic conditions, require to be tested.

(2) Seed farms are required for the distribution of pure strains of seed.

(3) Milling of paddy requires encouragement.

FOOD CROPS:—*Research.*—Improvement by selection and breeding of the principal food grains and curry stuffs grown in the Colony.

Investigation.—(1) Distribution of improved seeds from seed farms.

(2) Preparation of dried products from sweet potatos, manioc, plantains, etc.

FRUIT:—*Investigation.*—Improved varieties require to be imported and distributed. Grafting and budding from known superior stock in the Colony require to be systematically undertaken.

CATTLE:—*Research.*—The systematic investigation of the diseases of cattle and other live stock in the Colony requires further assistance.

Investigation.—The Colony depends for its draught cattle upon imports from India. It has been demonstrated that good stock can be raised in the Colony, and cattle breeding farms should be established or encouraged.

NATIVE DRUGS :—*Research and Investigation.*—Records of plants used in native medicine are being collected, but botanical and morphological identification is still incomplete. A pharmacologist is required for research work in conjunction with these botanical investigations. There is undoubtedly much to be learned in regard to the large number of medicinal plants which are used—apparently with good effect—in the Colony.

DEVELOPMENTAL EXPLOITATION.

Amongst possible new industries that require close investigation are the following :—

(1) SUGAR.—The Colony ought to be able to produce its own requirements of sugar, even if it could not produce any large quantity for export.

(2) FIBRES.—These can be grown in the dry zone of the Colony, and would constitute a valuable money crop for the villagers. Small scutching machines of the Raspador type can be secured and worked on a co-operative basis. A beginning in this direction has already been made at the Anuradhapura Experiment Station, where nearly 30 acres of fibres have been planted during the past two years.

LIMES.—There are areas in the Colony which appear to be just as well suited for lime cultivation for the production of citric acid as many of the lands under this crop in the West Indies. Limes grow luxuriantly all over the low-country where there is a sufficient supply of water, and considerable quantities find their way during the season to the Beliatta market in the Southern Province.

COTTON.—Cotton does well in the Hambantota District of the Southern Province. There were upwards of 40 acres in this district at the outbreak of war, but owing to lack of facilities for sale it has dwindled to an almost negligible quantity. An effort was made to revive its cultivation last year, but the demands for food crops prevented any extensive area being grown. Cotton might also be grown in the Dumbara Valley and in the Northern and Eastern Provinces. A co-operative purchasing scheme and the installation of ginneries are necessary for its development.

PINE-APPLE.—There are prospects for a pine-apple canning industry being capable of establishment.

CASTOR.—The growing of this crop in the dry zone should be encouraged. The demand for lubricating oil and for castor cake for manurial purposes assures a profitable industry.

FOOD CROPS—The local production of maize could be stimulated by provision of granaries on a co-operative basis. Beans and curry stuffs could also be grown to a greater extent in some of the drier areas up-country, and chillies in the low-country, if facilities for sale on a co-operative basis could be arranged.

CINCHONA.—This was once a staple crop in Ceylon, and further areas could be cultivated if the price was likely to be remunerative. Whether a sufficient area could be grown to warrant the erection of a factory for making quinine requires investigation. Otherwise it might be possible to arrange for supplying bark to any factory working in Southern India.

COCA.—The area under coca was recorded as only 97¾ acres in 1915. This cultivation has been stopped by the Excise Notifications No. 38 and 41 under "The Excise Ordinance, No. 8 of 1912," published in the *Ceylon*

Government Gazette No. 6,683 of November 20, 1914. There is no reason why Ceylon should not supply the Empire's requirements of cocaine the plantations being under Government supervision, and the cocaine extracted in a Government factory in Ceylon or in England, as may be decided upon.

PAPAINE.—The area under papaws for the preparation of papaine was increasing, but the latest advices indicate a complete slump in the market, and therefore planting is likely to be stopped.

TAPIOCA.—The manufacture of tapioca and farina from manioc is worthy of investigation. Its success depends upon a wholesome and abundant water supply, and the manufacture would thereby be limited to certain parts of the Colony.

EXPLORATION.

Botanical exploration was carried on systematically under former Directors of Botanical Gardens. A botanical survey on systematic ecological lines is, however, required, and plant associations in different parts of the Colony require investigation. There is an immense amount of work that still requires to be done. It is only when such investigations have been carried on from the standpoint of the scientific botanist that details of lasting value to the agriculturist will be available. Similarly, botanical investigations on ecological lines is an essential to any work which may be taken up in connection with a soil survey by the Chemist.

HOW THE WORK REQUIRED CAN BE ACCOMPLISHED.

The above enumeration of the works required must not be considered to be in any way exhaustive. From time to time other problems are bound to be brought forward and to demand attention.

My letter No. 137 of July 26, 1917, printed as Sessional Paper 1 of 1918, indicated the directions in which I thought the Agricultural Department required strengthening, and in my letter No. 195 of November 3, 1917, I advocated the establishment of a Central Bureau for research in Tropical Agriculture, with travelling intelligence officers and research students for the Crown Colonies and Protectorates. The proposals submitted in the former letter have met with the general approval of agriculturists in the Colony, and the proposals submitted in the latter met with the support of the Governor of the Colony and the Director of the Royal Botanic Gardens, Kew.

Applied research in Ceylon in regard to agricultural industries should, in my opinion, be concentrated upon tea, rubber, coconuts, coffee, and paddy. The research work required for cacao could be carried out in Trinidad or the Gold Coast. Arrangements might also be made for the co-ordination of research work with tea with Assam, and with rubber with the Malay States. The investigational and developmental work is purely local in its character and application. It must, therefore, be conducted in the Colony itself.

What is required is the establishment of a well-staffed and equipped research station at Peradeniya for research work, and properly equipped provincial branches of the Agricultural Department for the control of the investigation, experiment, and developmental work. A beginning has been made in putting such a policy into effect. The present sanctioned staff

is as follows :—

Administration.—Director of Agriculture ; Office Assistant.

Research : Mycologists (two).—One performs the systematic botanical work, in addition to his mycological duties.

Entomologists (two).

Chemists.—Advantage is taken of the services of one Consulting Agricultural Chemist to Government. A Rubber Research Chemist is employed temporarily in conjunction with the Rubber Research Scheme.

Economic Botanist.—One recently sanctioned.

Plant Pest and Disease Inspectorate (two).—One Entomologist for tea area. One Mycologist for rubber area.

Manager, Central Research Station, Peradeniya.

Extension Work.—Three Divisional Agricultural Officers. One Acting, others recently sanctioned.

Botanic Gardens.—One Superintendent and two Curators—Kew trained.

School Gardens.—One Superintendent trained in India and in England (about to retire). Four Inspectors, locally trained.

The laboratory and office equipment of the Department is wholly inadequate. The Mycologists occupy a building which was formerly erected as a strangers' laboratory, for the use of scientific visitors to the Royal Botanic Gardens, Peradeniya. It is the only laboratory available. The Entomologists are located in small rooms which have been evolved out of old storerooms, and a small room is set apart on the Experiment Station as a laboratory, but it is not suited for other than very elementary work. The Department has no chemical laboratory of its own, having no supplies of gas or water yet installed. A beginning has been made to remedy this lack of accommodation. A central administration office will be erected in 1919-20, an entomological laboratory and insectory, etc., it is hoped, in 1920-21, a chemical laboratory in 1921-22, a proper mycological laboratory in 1922-23, and possibly a physiological or bacteriological laboratory in 1923-24.

The Rubber Growers' Association also provides for one Chemist and one Mycologist in Ceylon, but at present only the latter officer is available. Proposals for co-ordination and possible amalgamation with the Government Agricultural Services are now under consideration in London.

The present additional requirements of the Agricultural Department to give effect to the work above outlined consist of the following:

(1) One Physiological Botanist for research work in connection with tea and rubber.

(2) One Agricultural Chemist for research work in connection with soils, etc.

(3) One Bio-chemist for research work with rubber and tea.

(4) One Bacteriologist for research work in connection with soils, the moulds of copra, and the bacteriological diseases of plants and animals.

(5) Economic Botanist for rubber and coffee, in addition to the one already provided for paddy.

(6) One Mycologist, in addition to two already provided for rubber and coconut diseases.

(7) One systematic Botanist for ecological work.

(8) Five to six Provincial Agriculturists and their staffs, in addition to the three already sanctioned, for investigational work, demonstration, and developmental experimentation.

The temporary requirements would include a pharmacologist for work in connection with the medicinal plants of the Colony, and a fully trained technical chemist familiar with the technical sides of soap making and edible oil manufacture for the investigation of local manufacturing problems in connection with the manufacturing side of the coconut industry. These two scientists might be asked for from the Central Fund now established for research in the Crown Colonies in conjunction with the Department of Scientific and Industrial Research. It would not be advisable, however, to send out a Pharmacologist before the Systematic Botanist is provided, as the Chemist will depend upon the Botanist for the identification work. Investigations into the manufacturing side of rubber industry are also required, but in my view these should be dealt with by an association of rubber manufacturers in the United Kingdom.

FUNDS.

I have already indicated in previous reports dealing with the question of rubber research my reasons for advocating in Ceylon and other tropical colonies, where the main industries are agricultural, that the provision for scientific and agricultural researches should be the duty of Government, and that, if necessary, special taxes upon agricultural industries should be earmarked for particular schemes of research. I have further indicated that, in my opinion, in Ceylon, apportionments if necessary should be made from the special export taxes upon agricultural products adopted in the first instance as a war measure. Numerous examples have been cited in support of these proposals. If, then, any industry is not satisfied that sufficient provision is being made for research or investigation, it would be able to make provision—as has been done by the rubber industry of Java—to attach special officers to the Department of Agriculture for special investigations.

My original estimates for the cost of Research Staff of the Department were as follows :—

		Salaries. Rs.	Other Charges, Rs.
Research Officers ...	...	83,300	22,000
Central Research Station	...	12,200	25,000
Plant Pest and Disease Control	...	34,860	19,500
Allowances in lieu of quarters	...	—	7,500
		130,360	74,000
		204,360	

I have now suggested additions which might bring the total cost under the heading of Research and Plant Pest and Disease Control to approximately Rs. 250,000 per annum. The total expenditure during 1918-19 by Research Staff, including Personal Emoluments and Other Charges, amounted to Rs. 85,100, while the provision for 1919-20 amounts to approximately Rs. 120,000. A capital provision for bungalows, laboratories, and equipment for the Research Staff might be estimated to cost at least Rs. 50,000 per annum for the next five years.

The export taxes paid by the tea, rubber, and coconut industries average between six and seven millions of rupees per annum. I would suggest that a percentage of these taxes should in the future be ear-marked for research purposes, the same to constitute a general fund, to be called the Agricultural Research Fund. To this fund could also be contributed funds from the general revenue on behalf of the agricultural industries other than tea, rubber, and coconuts, any special donation for special work, and any contributions from such schemes as the Rubber Research Scheme. The balances at the end of any year should be allowed to be carried forward, and not to lapse into general revenue. The expenditure of the fund could be entrusted to recommendations from the Department of Agriculture, with the advice of the proposed Estate Products Committee of the Board of Agriculture. I feel strongly that a fund as indicated above should be formed, or otherwise research is likely to be starved for the apparently (to some) more urgent work of agricultural extension and educational work so desirable in the different Provinces. It must, however, not be overlooked that this extension of demonstrative and educational work depends wholly upon the research work that is carried on by the scientific staff. It must also not be overlooked that work on research may take years to carry out, and may in the initial years produce no results which may appeal to the ordinary layman. The basis of agricultural progress is research, and Ceylon in the East, with its varied climates and crops, has strong claims for being made a centre for such research.

GENERAL.

The Agricultural Department of Ceylon is looked upon as a centre for general information on tropical industries, and in recent years has received several appeals from other countries for assistance in regard to the investigation of diseases of tropical crops. It is central to many other colonies, and correspondence is received from estate owners, superintendents, and others in India, Borneo, New Guinea, Mauritius, Seychelles, East Africa, Zanzibar, Sarawak, and Fiji. Work for other colonies has gradually been turned down owing to the pressing needs of the industries of the Colony itself and by reason of scarcity of workers. There is no doubt, however, that Ceylon might serve as a useful centre. Scientific workers do better work if they are not scattered and isolated, and there would appear to be every reason to advocate that research officers who may be sanctioned for the smaller Eastern Colonies be attached to the Ceylon Agricultural Research Institute, and that they be allowed to visit the Colonies to which they are assigned from time to time for field work and investigation. This would be particularly desirable from the botanical and mycological standpoint. The Imperial Bureau of Mycology will prove useful as a central reference reviewing agency, but it has been demonstrated that research work in tropical mycology must be carried out in the tropics, and the establishment in Ceylon of an Imperial Mycological and Botanical station would appear to be desirable from the Imperial point of view. For the needs of Mauritius, Seychelles, and the tropical portion of East Africa special officers would be required. It has to be decided whether the needs of North Borneo, Sarawak, etc., could be best met in the Federated Malay States or in Ceylon. The laboratories of the Department of Agriculture, Ceylon, as

they will be new, should be designed on modern lines, and should have accommodation sufficient to allow of the higher training of the youth of the Colony in agricultural research, and of accommodating graduates from British Universities for post-graduate work in tropical Agriculture and botany. The work in Ceylon of the Frank Smart students from the University of Cambridge has been productive of good results, and could, with advantage to the Empire, be extended. No great extension could however be possible until laboratory accommodation and equipment and bungalows have been provided.

Similarly, I believe that fully qualified officers itinerating from one Colony to another and generally reporting on the work in progress to the Central Research Committee would be productive of useful results. The work of the average officer of an Agricultural Department in the tropics has increased during the past ten years to such an extent that he has little time to study in detail all the various reports that are now being issued. Much work is also being carried on, which from pressure of time does not become recorded. Some means should be devised for workers in the tropics to be kept in touch with the work of other tropical lands. The Review of the Imperial Bureau of Entomology has been most useful to Entomologists. It is anticipated that the Imperial Bureau of Mycology will, similarly, issue a review. These, however, do not wholly meet the requirements. Agricultural Chemistry in the tropics has to be considered, and, from the industries point of view, General Tropical Agriculture. What may be called itinerating "intelligence officers" are, in my opinion, most necessary.

As far as Ceylon is concerned, the housing of the research staff at Peradeniya is another problem that will require consideration. Bungalows will have to be built. The Department at present has for research officers bungalow accommodation provided for only the Entomologist and the Manager of Peradeniya Experiment Station. This is wholly inadequate, and there is no other suitable bungalow accommodation available at Peradeniya.

The Statistical Branch of Agriculture has to receive consideration in the Colony. The present agricultural statistics are inadequate and not sufficiently accurate. Agricultural statistics are essential if progress is to be made, and there would appear to be every reason to advocate that Ceylon should improve its system of statistics and endeavour to bring it up-to-date with other progressive Colonies of the Empire.

AGRICULTURAL RESEARCH STATION.

The following is the report of the Committee appointed to advise Government on the Financial Aspect of the Proposals put forward in connection with the Development of the Economic Resources of the Colony in so far as they relate to agriculture :—

This Committee entirely concurs in the view that "the establishment of the well-staffed and equipped research station at Peradeniya, with branches in the Provinces for the control of investigation, experiment, and development work advocated by the Director of Agriculture, should be proceeded with

without delay." They are satisfied that the present facilities for research work are inadequate, and they are confident that increased expenditure under this head is a sound business proposition. Relatively to the enormous sum represented by the total value of the agricultural industries and to the practical dependence, either directly or indirectly, of almost the whole revenue of the State upon these industries, the sum hitherto expended from revenue on agricultural research is really very small.

ANNUAL EXPENDITURE FOR RESEARCH STAFF.

The cost of the additional staff over and above that provided for in the 1919-20 estimates necessary to place this research work on a sound footing appears to be approximately Rs. 155,000 per annum, making the total annual cost of the research staff approximately Rs. 275,000 per annum as compared with approximately Rs. 120,000 in 1919-20. This does not appear to be an excessive sum, but it would serve no useful purpose to obtain the whole of the extra staff until the laboratories in which they are to work have been completed. We recommend, therefore, that the additions to the staff should proceed *pari passu* with the completion of the laboratories, etc.

The details of the proposed additions are as follows :—

(1) One Physiological Botanist for research work in connection with tea and rubber.

(2) One Agricultural Chemist for research work in connection with soils, etc.

(3) One Bio-chemist for research with rubber and tea

(4) One Bacteriologist for research work in connection with soils, the moulds of copra, and the bacteriological diseases of plants and animals.

(5) One Economic Botanist for rubber and coffee in addition to the one already provided for paddy.

(6) Four Mycologists in addition to two already provided, for rubber and coconut diseases.

(7) One Systematic Botanist for Ecological work.

(8) Five to six Provincial Agriculturists and their staffs, in addition to the three already sanctioned, for investigational work, demonstration, and developmental experimentation.

CAPITAL EXPENDITURE FOR LABORATORIES, HOUSES, ETC. FOR RESEARCH STAFF.

The capital expenditure which the Director has put forward as necessary to meet his immediate requirements in the way of buildings and equipment is as follows :—

	Rs.
Head Office	45,000
Entomological Laboratory	20,000
Mycological Laboratory	25,000
Chemical Laboratory	20,000
Physiological Laboratory	20,000
Library	20,000
Water Supply	54,000
Gas-making Plant	15,000
Primary Equipment	15,000
Bungalows (10)	150,000
	Rs. 384,000*

* We note that part of this expenditure has actually been provided for in the 1920-21 Estimates in advance of our recommendation.

To this must be added the cost of land for the bungalows, as it is stated that there are already too many buildings inside the Gardens, and that it is most undesirable to add to the number.

This is a very considerable capital expenditure, but it appears to this Committee to be absolutely necessary. We are, however, of the opinion that it is quite unnecessary to ask the Legislature to vote this expenditure at once, as we are satisfied that the money could not be spent within one financial year, and will therefore only be needed in instalments spread over two or probably three years.

PROPOSED AGRICULTURAL RESEARCH FUND.

We do not find ourselves in agreement with the Conference, where it supports the recommendation of the Director of Agriculture that a part of the export duties should be paid into a separate Agricultural Research Fund. The determination of the sum to be expended upon agricultural research is a matter of policy to be settled year by year. The suggestion to divert a portion of the revenue from export duties into a separate channel can have only one motive, viz., to take the direction policy, in so far as it affects the expenditure of the revenue so diverted, out of the hands of those whose business it is to direct policy and to place it elsewhere. The Director of Agriculture explained to the Committee (*vide* minutes of the second meeting) that "what he wanted to be assured of was that *the necessary money for research* would be forthcoming," but this remark begs the whole question for decision, viz., what amount of research, etc., *ought to be* undertaken. Government and the Legislature must be the ultimate arbiters upon that point.

AGRICULTURAL COLLEGE.

We invite attention to MR. STOCKDALE's remarks regarding the proposed establishment of an Agricultural College, and we endorse his view that this does not require immediate consideration.

MANUFACTURE OF RUBBER GOODS.

Turning now to the proposals made for the stimulation of specific agricultural industries, we note that MR. CHAPMAN's Conference was of opinion that the manufacture of rubber goods "should receive special encouragement and assistance," but we do not advise Government action in this matter, which, in our opinion, should be left to individual enterprise.

PADDY GROWING.

The question of the local cultivation of paddy and the cognate questions of the provision of additional irrigation facilities and the prevention of cattle diseases have been exhaustively examined by other Committees, and we do not think we should assist Government by generally reviewing the question. There are, however, two concrete suggestions put forward by MR. CHAPMAN's Conference, upon which, we think, we should record our opinion.

MAINTENANCE OF PRICE OF PADDY AT THE PRESENT FIGURES.

The Conference suggested "the maintenance of the price of paddy at the present figure," but did not suggest any method by which this should be effected. We are very doubtful of the economic soundness of the policy of maintaining the price of paddy at a high level by artificial means, but we are

inclined to think that some steps in this direction will have to be taken in view of the policy of stimulating local food production already adopted by Government. While locally-grown paddy should, in our opinion, be left to find its own market, Government *not* undertaking to purchase it in any circumstances, we would recommend that in the event of the cost of imported rice falling below Rs. 6 a bushel during the next two years, or Rs. 5·50 during the two subsequent years, or Rs. 5 during the fifth year, an import duty should be imposed, so calculated that it would bring the cost of imported rice *ex* Colombo Granaries up to these limits and so give a substantial measure of protection to home-grown rice. In making this suggestion, we wish to point out that the effect of its adoption would operate somewhat unevenly as between estates and industries near and those at a distance from a port. The local producer would be able (until there was an actual surplus of locally-grown rice) to exact a price equivalent to the cost of imported rice *ex* Customs *plus* cost of transport to place of consumption. In some cases this would give the local producer an extravagant price, and it may be necessary, while protection of the rice industry lasts, to continue the present practice of allowing free transport of rice by rail in order to reduce the possibilities of "profiteering" on the part of the local producer.

ESTABLISHMENT OF RICE MILLS.

We endorse the proposal to establish one or two *experimental* rice mills in order to demonstrate the best methods and to supply information, but we think Government action should not go beyond this, and that no mill should be established in a place where private enterprise can meet requirements.

SUGAR CULTIVATION.

This Committee entirely endorses the recommendation of the Conference that the Department of Agriculture should carry out experiments in the cultivation of sugar cane on a sufficiently extensive scale to demonstrate whether such cultivation is commercially possible. It will be seen that the proposals made by MR. STOCKDALE for carrying out the experiments would involve the cultivation of two areas of about 20 acres each, one in the dry zone and the other under a tank. He estimates the cultivation charges at Rs. 350 per acre, and the cost of the outfit required for dealing with the output of an area of 20 acres at Rs. 10,000. The cost of the experiment—apart from the value of the land—would thus be (Rs. 350 by 40) + Rs. 20,000= Rs. 34,000. In view of Ceylon's annual consumption of 40,000 tons of imported sugar, we are of opinion that an expenditure of Rs. 40,000 to Rs. 50,000 from revenue on experiments which might demonstrate the possibility of the local production of this quantity at as cheap a price as that now paid for imported sugar would be fully justified. We are not, however, in favour of the establishment at Government expense of factories for the manufacture of sugar from palmyra toddy as recommended by the Conference. This can well be left to private enterprise.

COTTON CULTIVATION.

The prospects of successful cotton cultivation in the Hambantota District appear to us sufficiently good to justify experiments at Government expense. We advise (1) that Government should open up 50 acres in that District, and (2) should offer to purchase for a period of years at a fixed price all the cotton produced by any private cultivators who may come forward to assist

in the experiment up to a limit of the output of a further 50 acres. The cost of the experimental cultivation suggested is estimated by MR. STOCKDALE at Rs. 300 an acre or Rs. 15,000 for the cultivation of the area proposed. The offer to purchase the output of 50 acres of privately cultivated land should not involve any considerable expense.

OTHER PROPOSALS.

Fibres, castor, and cinchona. As regards the other proposals made by MR. CHAPMAN'S Conference we understand that experiments are being made on a small scale in Sisal cultivation at Mahailuppalama and Anuradhapura, and also in the cultivation of the Castor plant at Anuradhapura, Madawachchi and Irnamadu. Such experiments as these, which would include the experimental cultivation of cinchona, to which MR. CHAPMAN'S Report refers, appear to be within the existing financial resources of the Department of Agriculture, and do not call for any special consideration from this Committee.

SUMMARY OF RECOMMENDATIONS UNDER AGRICULTURE.

To sum up this Section of our Report we recommend—

(a) The strengthening of the Research Staff at an additional cost of Rs. 155,000 per annum.

(b) The provision of laboratories, equipment, and bungalows for this additional staff at a cost of Rs. 384,000 exclusive of cost of land for the bungalows.

(c) Protection for home-grown rice in diminishing degree during a period of five years by means of a Customs duty on imported rice.

(d) The establishment of one or two rice mills for demonstration purposes.

(e) Experiments in the cultivation of sugar-cane and extraction of sugar at a cost of Rs. 44,000.

(f) Experimental cultivation of 50 acres of cotton at a cost of Rs. 15,000 and an offer to purchase the output of an additional area of 50 acres.

We do not recommend—

(g) The creation of an agricultural Research Fund by the diversion from General Revenue of part of the Export duties on agricultural products.

(h) Any immediate action towards the establishment of an Agricultural College.

(i) Government action in initiating the local manufacture of rubber goods.

And we have no special remarks to offer in regard to—

(j) The proposed experiment in the cultivation of Sisal, Castor and Cinchona which appear to be well within the financial resources at the disposal of the Department.

TRANSPORT AND CATTLE.

The questions of transport and cattle concerning which MR. CHAPMAN'S Report contains some general remarks are closely connected with the question

of the agricultural resources of the Island, but we can make no recommendations of a financial character. With reference to the suggestion that "a reasonable reduction of railway freights appears both desirable and necessary in regard to certain classes of goods," we do not think that any material assistance to agriculture can be expected in this direction. There is probably room for some readjustment of rates as between various classes of goods, but anything like a general reduction appears to us to be absolutely forbidden, in present circumstances, on economic grounds. In regard to cattle breeding MR. STOCKDALE suggested to us that the best method of encouraging the improvement of cattle breeding would be to give spare bulls from the Government Dairy farms to the Village Committees of villages which own a sufficient number of cattle to justify the gift. If nothing but the trifling loss of revenue involved stands in the way of adopting this course, we strongly recommend it.—SESSIONAL PAPER, No. VI, 1921 *re* The Development of the Economic Resources of the Colony.

FOOD PRODUCTION COMMITTEES.

KALUTARA.

Minutes of a Meeting of the Food Production Committee, Kalutara District, held at the Kalutara Kachcheri, on 9th August, 1921.

Present:—Mr. T. A. Hodson, Asst. Govt. Agent, in the Chair; Messrs. L. M. W. Wilkins, F. H. Griffith, W. N. Goonewardene, Mudaliyars Edmund Peiris, D. T. Perera, J. J. de Mel, and D. A. Emilian, Messrs. S. O. Felsinger, Asst. Conservator of Forests; W. F. Seneviratne, Agricultural Instructor; G. Auchinleck, Divisional Agricultural Officer, S.D.; and E. H. S. Karunaratne, Kachcheri Mudaliyar, Secretary to the Committee.

The Minutes of the last meeting were read and confirmed.

(1) Read letter No. 1050/21 of the 13th July, 1921, from the Divisional Agricultural Officer, S.D., on the subject of Agricultural Shows for 1921.

MUDALIYAR EDMUND PEIRIS was opposed to the holding of Shows on the ground that the benefits accruing from them were infinitesimal compared to the expense involved. The sense of the meeting was however in favour of Shows, and it was decided (MUDALIYAR PEIRIS alone dissenting) to hold a District Agricultural Show at Kalutara next year, if found to be possible.

(2) Read letter No. 1052/21 of the 13th July, 1921, from the Divisional Agricultural Officer, S.D., regarding arrangements for crop Competitions, 1922.

Resolved that the following competitions be held next year:—

Paddy Transplantation
School Gardens
Home Gardens for School children
Vegetable Gardens
Police Gardens

It was stipulated that, before any other competitions, paddy transplantations should have priority of claim to the extent of at least Rs. 400 on any Government grant.

(3) Read letter No. 625/21 of the 11th May, 1921, from the Divisional Agricultural Officer, S.D., regarding lectures or addresses on topics of agricultural interest.

It was considered unnecessary that these lectures should be held under the auspices of the Food Production Committee, and it was decided to let the Mudaliyars or any other members of the Committee arrange for the lectures in direct communication with the Divisional Agricultural Officer. These lectures should be delivered not only in the large towns, but also in places like Matugama, Agalawatta, Horana, Wadduwa, Paiyagala, Beruwala, Alutgama, etc.

(4) Read letter No. 713/21 of the 23rd May, 1921, from the Divisional Agricultural Officer, S D., forwarding draft rules for Vegetable Garden Competitions.

Rules taken as read. Printed Leaflets have been distributed by the Department of Agriculture.

(5) Read letter No. 598/21 of the 5th May, 1921, from the Divisional Agricultural Officer, S.D., forwarding extracts from the TROPICAL AGRICULTURIST on Garden Competitions.

Taken as read, as all members of the Committee take in the TROPICAL AGRICULTURIST.

(6) Read letter No. 543/21 of the 28th April, 1921, from the Divisional Agricultural Officer, S. D., forwarding a copy of a summary of results of paddy manurial trials in the Southern Division in 1920-21.

As this summary has since been published in the TROPICAL AGRICULTURIST the members were referred to that periodical.

(7) Read letter No. 341/21 of the 17th March, 1921, from the Divisional Agricultural Officer, S.D., forwarding a memorandum on the distribution of Agricultural Instructors in the Southern Division.

The Chairman pointed out that the number of Instructors in the Kalutara District, viz., two, is wholly inadequate, compared to the Galle and Matara Districts, which have three each. The Committee thereupon resolved that the Department of Agriculture be asked to provide four Instructors for this district, i.e., one for each Chief Headman's division. If this is not practicable at least three Instructors should be provided, one for Rayigam Korale and Panadura Totamune, one for Kalutara Totamune and Pasdum Korale West, and one for Pasdum Korale East. The feeling of the Committee was unanimous that Pasdum Korale East being the most backward and least accessible of the Chief Headmen's divisions in the Kalutara District, a separate Instructor for that Korale is essential. It was observed that, sometime ago, there were three instructors in the Kalutara District, one of whom was paid by MR. C. E. A. DIAS, but that subsequently the number was reduced to two.

(8) Tabled copy of Administration Report of the Department of Food Production for the year 1-4-20 to 31-3-21.

It was decided to circulate this.

(9) The Chairman intimated to the Committee that, on the suggestion of the Mudaliyar, Pasdum Korale East, he had asked the Government Agent to approve the appointment of Vel Arachchies in that Korale in order to supervise the Vel Vidanes, as, owing to heavy work in connection with illicit clearings, the Vidane Arachchies found no time for this duty. The Chairman then explained that, in this connection, he found that no Advisory Committee had been appointed for the Kalutara District, under Section 5 (2) et seq. of "The Irrigation Ordinance, No. 45 of 1917," and that he was about to apply for the Governor's approval of the exemption of this District from the operation of the provisions of Chapter 2 of the Ordinance, except Section 5 (1), on the ground that no public meeting adequately representative of the proprietors of the district can be convened for the election of a Committee, and that, in his opinion, such a Committee was unnecessary in this district. The Committee agreed with this view, and the Chairman intimated that a paragraph to this effect would be added to the draft letter.

(10) Read letter No. 1134/21 of the 28th July, 1921, from the Divisional Agricultural Officer, S.D., asking that the following matters be dealt with :

(a) Report of work at Bandaragama Gardens.

(b) School Gardens competitions for MUHANDIRAM W. D. FERNANDO VAIDYASEKARA'S prize.

The Divisional Agricultural Officer, S.D., said that (a) would be sent later. Re (b) he said that there were 23 entries among School Gardens for this medal. There would be three judgings by the Department of Agriculture. The final judging will be done by the Divisional Agricultural Officer in May, 1922. Intermediate reports will be sent to the Committee.

(11) Read letter No. 4258 of the 22nd July, 1921, from the Director of Agriculture, forwarding notice re Paddy Cultivation Competition in Ratnapura District, 1921.

Notice taken as read, as it is practically identical with that in use in this district.

(12) Read letter No. 4499 of the 3rd August, 1921, from the Director of Agriculture regarding Grants-in-aid for Agricultural Shows and Competitions during the year, 1921-22..

Proposed by MR. L. M. W. WILKINS and seconded by MR. F. H. GRIFFITH.

"That as it has been decided to hold a district Show in Kalutara next year, the cost of which is likely to exceed Rs. 3,000 and as in addition, it has been decided to spend at least Rs. 400 on prizes for transplanting of paddy, it is hoped that the Government Grant-in-aid for Shows and Competitions will be considerably larger than in previous years and more in proportion to the population and importance of the district."

Carried unanimously.

GALLE.

Minutes of a meeting of the Galle District Food Production Committee held at the Galle Kachcheri on 11th August, 1921, at 2-30 p.m.

Present:—The Government Agent, S.P. (in the chair), the Divisional Agricultural Officer, S.D., the Mudaliyar. Four Gravets, Galle: Messrs. J. P. de S. Adihetty, P. A. de Silva and W. A. Goonetileke.

1. *Vegetable Competitions, 1921-22.*—Read letter from the Director of Agriculture inquiring what are the requirements of this district for 1921-22. Decided that a sum of Rs. 450 be applied for, explaining that it is important to hold these competitions in every Pattu every year.

2. *Agricultural Shows.*—Read letter of the D. A. O. on the subject and his suggested scheme of Shows for the next four years. Decided that—

(a) The Mudaliyars of Bentota-Walallawiti Korale and Hinidum Pattu be requested to ascertain the feeling of the people in respect of Shows at Elpitiya and Hiniduma in 1922.

(b) A grant of Rs. 100 be asked for village shows next year.

3. *Crop Competitions.*—Read letter from the D. A. O. on the subject. Decided that application be made to the Director of Agriculture for a grant of Rs. 200 for paddy transplanting trials during 1922 in B. W. Korale and Talpe Pattu.

4. Read reply of the Director of Agriculture to application for funds for the destruction of monkeys.

5. *Agricultural Instructors and Village Shows:*—Read letter from the D. A. O. with regard to the election of Agricultural Instructors on Village Show Committees. Resolved that it is desirable that the Instructors should be on these Committees and that the Government Agent, S. P., be requested to write to the Mudaliyars on the subject.

6. Tabled the Administration report of the Director of Food Production. Resolved that it be circulated among the members.

7. Tabled copies of Rules on Garden Competitions. Resolved that copies be sent to the Mudaliyars.

FOODSTUFFS.

CHOLAM (SORGHUM VULGARE) VARIETY TRIALS AT ANURADHAPURA AND JAFFNA.

N. MARSHALL,

Divisional Agricultural Officer, Northern, Department of Agriculture, Ceylon.

Cholam, Kaffir corn, Great Millet—to give some of the names this plant is known by—is largely cultivated in the drier and upland regions of India and furnishes a large proportion of the food for both man and beast in that country. The grain gives excellent flour for cakes, etc., and the straw is nourishing and well liked by stock: and also the yield of straw is heavy—and it is with the idea of introducing this crop into the Island that these trials have been conducted.

In India, Cholam is grown in areas of moderate rainfall and particularly in rotation to cotton on Black Cotton Soils. It is also grown during the hot weather on irrigated lands partly for grain but chiefly as a fodder crop for stock, and cut green.

A particular quality of this millet is that it will grow and give good crops in dry regions and prefers a climate where the temperature does not fall below 60°F.

There are two big classes of Cholams each containing a large number of varieties. (1) The Autumn sown, (2) The Spring sown, and care should be taken to get the correct variety for the season—although a large number of cholams will flower and produce grain when sown in either season, yet there are also large numbers that will not; they will probably grow but will only produce straw and no grain will come, and this is a point to guard against. And over and above these there is a third class called Fodder Cholams—not grown for grain—these are thin stemmed quick-growing good tillering varieties.

Seed Rate.—Usually 8—15 lb. per acre.

Method of Sowing.—Drilled in rows 14 in.—2 feet apart and then singled so that plants are 1 foot apart in the rows.

Time of Growth..—Plants sown in June will be ready for harvest in November (i.e.4½ — 5 months).

The following are the results from trials at Jaffna and Anuradhapura. 7 varieties were tried at Anuradhapura and 4 at Jaffna. The first three varieties are from seed from Egypt and the other four from seed from America.

AT ANURADHAPURA.

Name of Variety	Where from	Date of sowing	Distance	Harvested	Yield per acre grain	Yield per acre straw
Millet gattara	Egypt	14·2·21	18 in. × 18 in.	30·5·21	480 lb.	2,290
,, ata	,,	14·2·21	,,	do	240 ,,	1,190
,, sabeini	,,	10·2·21	,,	31·5·21	360 ,,	2,200
Pink Kafir	America	16·3·21	,,	14·6·21	420 ,,	1,900
Dwarf Milo	,,	15·3·21	,,	do	1,260 ,,	2,100
Dawn Kafir	,,	16·3·21	,,	do	660 ,,	1,600
Feterita	,,	do	,,	do	960 ,,	1,986

AT JAFFNA.

Feterita	America	21·2·21	6 in. × 6 in.	12·6·21	1,650 lb.	16,200
Dwarf Milo	,,	do	,,	do	1,200 ,,	11,500
Dawn Kafir	,,	do	,,	do	850 ,,	19,200
Pink Kafir	,,	do	,,	do	900 ,,	14,000

These results show that the seed from America in both trials is much better than that from Egypt. And the crops grown at Jaffna have given better results than those at Anuradhapura particularly in the amount of straw. The amount of straw at Anuradhapura although good for Ceylon is below the Indian average but that at Jaffna is nearly double the Indian average.

But these trials clearly indicate what a very valuable food and fodder crop cholam is. These trials are to be repeated.

ANALYSIS.

The following is an analysis of Cholam grain and straw made in Madras, and also paddy grain and straw.

Grain	Water	Protein	Oily fat	Carbo-hydrates	Fibre	Ash	Nutritive Ratio.
Cholam	10·1	9·71	3·69	73·38	1·54	2·05	1: 8·3
Paddy	13·55	6·35	2·14	65·29	7·84	5·83	1:11·0
Straw							
Cholam	8·70	2·10	1·50	39·67	39·79	8·24	1:21·4
Paddy	11·04	2·70	1·02	40·84	29·23	15·17	1:19

SWEET POTATO VARIETAL EXPERIMENTS.

Some twenty-six new varieties of sweet potatos were raised last year. Of these, twenty were discarded on account of their undesirable characters, low productivity, or indifferent flavour. The remaining six varieties were planted in plots on November 15, and reaped on February 27, the time taken for them to mature being 104 days.

A variety known as "White Kind," which is extensively grown in this island, was used as a standard against which to test the new varieties.

The results obtained are given in the following table:—

Variety	Calculated Yield per acre in lb.	Difference on Yields of 'White Kind.'
White Kind	5,277	—
V 7	7,489	+ 2,260
V 6	6,970	+ 1,743
V 16	6,387	+ 1,162
V 8	6,450	+ 1,223
B 3	3,539	− 1,688

These results are not to be taken as conclusive: further extensive trials are being conducted.

The following remarks as to the cooking qualities, etc., of these new varieties, may be of interest.

Variety	*Description of Potato*	*Cooking Qualities.*
V 7	Medium-sized, white, elliptical, small	Good, white, dry
V 6	,, ,, ,, ,,	,, ,,
V 16	,, ,, ,, ,,	Excellent
V 8	,, ,, ,, ,,	Good
B 3	Small, white, round, smooth	,,

—REPT. ON AGRIC. DEPT., ST. VINCENT, April-December, 1919.

VARIETAL TRIALS WITH MILLETS.
At Anuradhapura Experiment Station.

VARIETAL TRIALS WITH MILLETS.
At Anuradhapura Experiment Station.

STORING SWEET POTATOS.

L. A. BRUNTON,

Assistant Superintendent of St. Augustine, Experiment Station.

An experiment in storing sweet potatos was made last year at the Experiment Station, St. Augustine.

Two lots of potatos, one of 400 pounds and one of 200 pounds, were stored separately on March 6 and 11 respectively, just after having been dug, the method employed being as follows:—

A flat level piece of ground was selected upon which a thick bedding, six inches in depth, of thoroughly dry banana leaves was spread; upon this the potatos were heaped to form a cone, and covered with a layer of dried banana leaves six inches thick; finally the heap was covered with four inches of earth well beaten down and smoothed over. To ensure thorough drainage a trench was dug around the heap. For the purpose of ventilation a bamboo pipe was inserted in each heap, to allow the escape of heated air during the first fortnight, the projecting end being fitted with a plug.

On April 16 one month later both heaps were opened, when half the contents of the 400 pounds heap were found to be rotten, the sound potatos being generally on the outside of the heap, these were repacked in layers, dry banana leaves being placed between each layer, re-covered with dry trash and soil as before, and left for another month, when reopened on May 20 all the potatos were rotten.

The potatos of the 200 pounds heap, which was opened on the same dates, were, with a few exceptions, found to be sound; reopened a month later, on June 12 the potatos were still in good condition, and when finally opened on July 8, four months after storing, although some root growth had taken place, they were still perfectly sound, palatable, potatos, cooking dry and floury, and with an excellent flavour.

The loss in weight due to drying and the few which had rotted amounted to 40 per cent.

The rainfall at the Government Farm, St. Joseph, during the period of this experiment was as follows:—

March—1·26 inches.	May—0·20 inches.	To July 8th-2·04 inches.
April — Nil	June—6·42 ,,	

It is therefore apparent that sweet potatos can be stored for four months, provided the heaps are moderate in size, and the contents are kept from direct contact with the soil by a liberal covering of dry trash.

An experiment on a larger scale is in progress this year.

LIVE STOCK.

THE SCIENCE OF STOCK BREEDING.

MENDELISM, ITS MEANING AND USEFULNESS.

In modern writings on breeding and heredity the word mendelism is used frequently, but much misapprehension exists as to its meaning and implications. Mendelism is generally used as co-extensive with the modern science of Genetics. The foundations of the new knowledge were laid by GREGOR MENDEL, an Austrian Abbot, who lived in the "Sixties" of last century. He was a contemporary of DARWIN, and it cannot be doubted that his discoveries, had they been communicated to the latter man of science, would have influenced his views profoundly. As it was, MENDEL'S work remained unnoticed until the beginning of the present century.

A DISCOVERER OF FACTS.

Now, MENDEL was the discoverer of certain facts as well as the propounder of a hypothesis or theory to explain these facts. It is with these facts and not with the scientific hypothesis which may explain them that it is proposed to deal. For these discoveries are of interest to practical men and can be used with advantage by the stock breeder and seed-grower. The science of Genetics is still young; it does not explain all the facts of heredity, but it has introduced precision into many of the questions before the practical breeder. It has already proved a powerful weapon in the hands of the plant breeder, and if it has so far achieved little in relation to animal breeding, there is some reason to hope that it will be of use in this field also.

REDUCING UNCERTAINTY.

It is true that a great deal was known of breeding before MENDEL. The British breeds are a result of that knowledge and the skill with which it was applied, but such knowledge as existed was not sufficiently precise to be stated in the form of laws, that is there was no science of breeding of inheritance. For example, it was known broadly that "like begets like," but with many exceptions. We now know definitely why in many cases there are such exceptions. It was known that cross-breeding led to variation to the production of mongrels "blended" and even new forms. But we can now in many cases (not in all) predict with certainty what the result of a cross of a cross will be. The field of uncertainty is smaller. In the aggregate the progress that has been made is perhaps not great, especially in regard to animals. But some laws have been discovered, and cases occur in which we can predict with certainty what the result of crossing will be.

THE TRANSMISSION OF QUALITIES.

In order to understand the new knowledge we must first get rid of the ideas that are associated with the use of the word "blood" in connection with breeding. In considering a "cross" we should not think of a mixture of blood, which in successive generations gets diluted to half blood, quarter

blood, and so on, for, in regarding inheritance from this point of view, it is assumed that all the qualities of one parent pass in some degree to the child either in an open or latent form, and that any one of these qualities may appear in a successive generation. But we now know as a fact, independent of any theory, that the parent does not necessarily transmit all or any portion of all his qualities to his offspring, and that, in many cases, "reversion" may be entirely ruled out. Or, to put it in other words, we know that the germ cells of a parent often do not contain certain of the qualities of the individual producing them, and that, consequently, the offspring does not possess, and therefore transmit these qualities. For example, if we mate two Andalusian fowls it is well-known that some of the offspring will be white. It has been proved (there is no theory in this) that however long we go on mating these white birds together the blue of the Andalusian will never return again, dark-eyed parents may have a blue (or grey) eyed child. We know that child has no tendency to beget the dark eyes of its parents. A quality if absent from a germ cell cannot be transmitted to the next generation, and the construction of the germ cell differs from that of the parent. Qualities present may be absent from the germ.

PROOF ONLY IN THE OFFSPRING.

The main advance in knowledge, therefore, is that the possession of a quality does not necessarily imply a power to transmit that quality. For example, it does not follow because a cow gives a high yield of milk that she will transmit that character to her offspring. In other words, external appearances may or may not be present in the germ, and we cannot be sure that they were present in their germ until they appear in the offspring. If this view is correct—and it has proved correct in many instances—the practical deduction is that the full value of an individual (whether plant or animal) as a parent cannot be predicted with certainty until its capacity to transmit its qualities has been established by the appearance of these qualities in the offspring.

CROSSING PRINCIPLES.

Another addition which the new knowledge regarding inheritance as given us is this :—Consider any variety of pea. It may be tall, or dwarf; it may have wrinkled seeds or round seeds. Suppose it is a tall variety with round seeds. When it is cross-bred we find that tallness is not always associated with round seeds. Just as a house built partly of brick and partly of stone can be pulled down and from the materials another house of brick only can be constructed, so, in cross-breeding a pea which is tall with round seeds, tallness may separate from round seededness and another pea plant may be produced which (say) is a dwarf variety with round seeds. Moreover, this new variety will "breed true," that is to say, it will never produce a tall plant again, although one of its grand-parents may have been tall. It will not be subject to "reversion" or "atavism." According to the new knowledge, therefore, an individual must be regarded as an assortment of many qualities which reappear or disappear in its offspring. It is like a hand dealt from a pack of cards; when it is shuffled with another hand it loses its character as a hand, though the cards of which it was composed are still there. Mendelism, of course, goes further than this. In certain cases it enables us to predict not only the character of the offspring but the precise numbers of each variety of offspring. So that in certain cases the knowledge of the modern geneticist is as precise as that of the astronomer who predicts the exact hour of an eclipse.

LIMITED KNOWLEDGE.

But this precise knowledge, so far, is woefully limited, particularly in regard to animals. In plants (such as wheat) the new science has already borne practical fruit. The same can hardly be said of animals. But no one will now set bounds to the possibilities of science. Our knowledge is always being extended, and one day we may know enough about the breeding of stock to be able to abolish the element of doubt which at present makes all experiments in breeding so uncertain.

VALUE OF PREPOTENCY.

Enough has been established to justify this assertion. We should base our opinion on the value of an animal as a sire or dam for breeding purposes not on its appearance or performance, but on the qualities of its offspring. In popular language, if it is not "prepotent" it is of little value. In fact, Mendelism explains prepotency as well as reversion, two expressions often used by practical breeders and influenced by chance. One practical deduction may be given as an example. It may be taken for granted that practical men recognise that certain bulls have the faculty of producing daughters giving a high yield of milk. If that is so, what excuse is there for the well-nigh universal practice of sending dairy bulls to the butcher before the performance of their daughters can be ascertained? This consideration has already been recognised by the Belgian and Dutch breeders of milch cows who award prizes to bulls which can show the best record of milking daughters. The same idea is influencing the American breeders who have started the registration of bulls on the same basis. In conclusion, it should be pointed out that Mendelian ideas are not necessarily derogatory to pedigree breeding. After all, pedigree is the best evidence that the good qualities sought for are likely to be found in the offspring. Mendelism simply points to ways in which this likelihood becomes a certainty. It proves a "proof" of pedigree—a test justifying ancestry.—

FARMERS' JOURNAL, VOL. 3, NO. 19.

CATTLE IN JAMAICA.

In the JOURNAL OF THE JAMAICA AGRICULTURAL SOCIETY for February, 1921, appear some notes by MR. CRADWICK, Supervising Agricultural Instructor, in a lecture delivered by HON. H. H. COUSINS, M.A., Director of Agriculture, on the subject of Jamaica Cattle. The substance of this interesting lecture is given below.

The chief breeds are the 'Mysore,' 'Gujerat,' 'Nellore,' 'Hissar' and 'Montgomery' (Shiwal). Of these, the 'Mysore' although sometimes appearing a little deficient in size, were the Aristocrats of India Draught Cattle, standing in the relative position of the Thoroughbred to all other horses. They had been bred and selected for many generations by the Maharajah of Mysore, which had resulted in a pure breed of great prepotency. Of these he is importing thirteen bulls. The Gujerats are a large, excellent, general utility breed of Indian cattle, giving up to 5 quarts of milk per day. Of these, four bulls have been imported.

The Nellore is the largest breed of cattle in India, often standing 15·2 in height, and weighing from 1,800 lb. to 2,000 lb., giving 6 to 7 quarts of milk per day, when well fed. Their defect is that they are slow in breeding.

The Hissars. There is strictly speaking no breed of this name, but a breed is being evolved at the large Government Farm of that name, and all cattle sold from there now are called by that name. The Hissar Farm is a large and justly celebrated one, with a herd of 10,000 head of cattle. The Farm has been in existence for many years, but whereas formerly no care was taken in the breeding of the cattle, of late years this has been changed, all the inferior cattle having been sold, a herd book started, and the cattle are now bred on scientific systematic lines, which will result in a standard breed being established. Of these five bulls have already been imported, and ten more ordered, MR. CLARENCE LOPEZ having bought one at the highest price yet paid for one of these animals.

The 'Montgomery' breed which, as its name would indicate, has been Godfathered by the inevitable Caledonian, was originally known as the 'Shiwal' and was taken in hand by the 'rale' Montgomery on account of its good milking qualities. It is believed that this is really an Indian Jersey breed; at any rate no cow is admitted to the herd book with a capacity of less than 4,000 lb. of milk for a single period. This breed crossed with the 'Ayrshires,' has given the best milking results in the tropics so far, having a record of 7,000 lb. of milk per annum. One bull of this type has been imported.

The Director pointed out that one drawback of the Indian breeds is that they breed slowly, the average being one calf per cow in twenty months. One herd, however, in Jamaica, where records had been kept had been found to be producing one calf per cow in twenty-six months not on account of the amount of Indian blood in the herd, but because no records had been kept, and so nothing was known of the records of either bull or dams. An infusion of Indian blood with any European breed was an improvement in enabling them to endure tropical conditions, ticks, etc. The Director was of opinion that the Hereford and Sussex breeds would both be useful importations to recross with animals with Indian blood.

Beef Production.—MR. RICHARD HARVEY, Nonpareil, Westmoreland, will go back to the Hereford breed for recrossing with his Indian blooded cows.

MR. COUSINS then described the Hereford Cattle formerly such a feature of Annandale Pen in St. Ann, the raising of which, as pure breeds, was finally made unprofitable through mortality caused by Texas Tick Fever, introduced on imported cattle. In order to counteract the effects of the Texas fever, Indian blood had to be introduced. This, while enabling the Pen to fight the Texas fever, destroyed the herd from a breeder's point of view. MR. COUSINS is however of opinion, that once the island is rid of ticks, pure bred herds, such as the Annandale Herefords will again be a possibility, with the consequent improvement in the quality of the beef.

The Shorthorns, the pride and glory of the British breeder, he described as an absolute failure in Jamaica.

The North Devon had been a great success in Jamaica, and MR. A. C. L. MARTIN was of opinion that, under similar circumstances as exist in South Manchester, this breed is absolutely the best.

Under conditions which exist in Westmoreland, MR. R. HARVEY pins his faith in Herefords, and has paid £200 each for bull calves in England. Probably under similar circumstances, in any other part of Jamaica, the Hereford would be hard to beat. The famous herd of Knockalva is too well known to need mentioning, and only ticks caused anything but pure Hereford bulls to be used there. Once ticks are under control, doubtless this herd will be resuscitated, at any rate it will be easily possible.

Aberdeen-Angus was pointed out as the producer of beef of the very highest quality, not inclined to run to 'gaudiness,' but producing beautifully 'marbled' beef. MR. COUSINS advised that great care be exercised with the calving of this breed, as if the droppings take place in very dry weather, the calves do not thrive. An Aberdeen-Hissar Cross, however, appears to stand hard times well. One remarkable feature of the Aberdeen-Angus is their prepotency. If an Aberdeen Angus bull is used, no matter what breed it may be crossed with, the calves are nearly all sure to be black and hornless.

A bull of each of the North Devon and Sussex breeds had been imported by the Government Stock Farm. These probably represented the two oldest breeds of cattle in England, being doubtless those used by the Ancient Britons. The South Devon were probably the heaviest cattle in England, the bulls weighing as much as 3,000 lb.

Milk Production.—MR. COUSINS said, that it had been demonstrated that, in an arid place like Hope, starting with very small capital, milk production could be made to pay. During the year 1920, with a rain fall of half its usual low average, the value of the cattle had increased from £8,000 to £12,000, while they had sold £3,000 worth, the cash profits being from £2,500 to £3,000, while on the large pens where beef and draught cattle are raised under much more favourable conditions, one had to endeavour condensed milk in one's coffee for fear of starving the calves. MR. COUSINS pointed out that the breeds chiefly used in milk production at the Hope Farm so far, were Jerseys, Red Polls, Guernseys, and native selected cows. The Jerseys and Guernseys produced the richest milk, but for an ordinary retail milk, not butter business, it was possible to use a breed giving a greater quantity, even if an inferior quality of milk. To this end experiments are now being made with the Holstein breed, which he had hitherto thought unsuitable for conditions at Hope. MR. COUSINS, however, impressed his audience with the wonderful qualities of the Jersey and Guernsey breeds, from the butter-producing point of view. Cheese, he also pointed out, was an easy possibility in Jamaica.

The 'Brown Swiss' is the breed used by the Nestles Milk Company in Switzerland. They are very large, hardy, and great milk producers. A bull and six cows of this breed have been imported, and will go to Grove Place where the bull will be at service at a fee of 10*s*. plus a charge of 10*s*. for railway expenses, for cows sent to the Farm by train.—AGRIC. NEWS, Vol. XX, No. 497.

SOILS AND MANURES.

NITROGEN LOSSES IN URINE.

F. E. BEAR AND J. R. ROYSON.

More than half the nitrogen of farmyard manure is contained in the urine, hence the interest of the research undertaken by the authors on the losses of nitrogen in the urine of farm animals, more especially because many agriculturists usually keep the urine in tanks until the time when it is sprinkled on the fields. The expediency of keeping the liquid portion of the manure in this way having been much debated, the authors investigated the losses of nitrogen from urine :—(a) exposed to the open air ; (b) in Bunsen valve flasks ; (c) in closed flasks ; (d) in closed flasks but with the air replaced by carbon dioxide ; (e) absorbed in litter (replaced for the experiment by filter paper ; (f) covered with a layer of kerosene. These experiments showed that urine exposed to the air lost over 92% of its nitrogen in 8 weeks under temperature averaging 38°C.; under temperature averaging 5° less the same loss took place in 12 weeks, Urine not exposed to air lost on the other hand little or no nitrogen. Regarding the method of preventing loss of nitrogen by absorption in litter the effectiveness depends on the manipulation ; when the litter was allowed to dry there was a loss of 20% of nitrogen, but when it was kept moist the loss was 97%, the maximum observed in the different experiments. The use of kerosene for covering the urine is a good means of preventing loss of nitrogen, for in this case the losses were not greater than 6% during 8 weeks — INTERNATIONAL REVIEW OF SCIENCE AND PRAC. OF AGRIC., YEAR XI, No. 2.

THE EFFECT OF TEMPERATURE ON THE LOSS FROM CANALS DUE TO INFILTRATION.

L. CRANDALL.

The author examined the losses through infiltration from canals forming part of an irrigation in southern Idaho, and extended his researches to an irrigated area of about 2,559 acres. He found that the loss due to infiltration increases with the temperature of the water. Usually, the variation in temperature during a period of irrigation, (from about 10-21°C.) may lead to a variation of 30% in the loss due to infiltration, as shown by the appended table:—

Ratio between the loss of water at various temperatures and the loss at 45°F. (taken as equal to 100).

		Losses at		
		50°F	60°F	70°F
Losses calculated by the formula of	Hazen	109	128	146
	Schichter	107	125	143
Losses found in the North Side Canal System, except Jerome reservoir ; averages of 1916–1917		108	125	141
Losses found in Jerome reservoir (maximum depth, 16 ft. 6 in.)		123	173	218
Losses from Lake Wilson :—Depth 10 ft.		114	132	165
,, 14 ft. 6 in.		118	148	182
,, 19 ft. 6 in.		122	158	192
,, 24 ft.		126	166	200

INTERNATIONAL REVIEW OF SCIENCE & PRAC. OF AGRIC., YEAR XI, No. 4.

RELATION OF LIME TO SOIL FERTILITY.

The following is the summary and conclusions of experiments conducted by MESSRS. J. W. PATERSON, B.Sc., PH.D., and P. SCOTT, Chemist for Agriculture (Victoria), regarding the Relation of Lime to Soil Fertility:—

1. Lime tends to leave the surface soil through various channels and fresh applications become necessary to maintain fertility.

2. Carbonate of lime is the best form of lime for the soil.

3. Burnt and slaked lime are rapidly changed to carbonate when they are applied to land.

4. The rate at which lime acts depends on its fineness of division.

5. Lime, but especially hot lime, has a good effect upon the mechanical condition of stiff clays

6. Gypsum also coagulates clay, but it has not the beneficial action of lime in other directions.

7. Lime greatly hastens the production of nitrates.

8. It has a good effect in liberating potash and phosphoric acid especially when the latter is combined with iron or alumina.

9. Where required by soil, lime produces larger crops.

10. It produces root crops, which are of greater feeding value.

11. It may often be a profitable application to grass land.

12. Lime kills sorrel, docks, and other acid-loving weeds.

13. It is specially stimulating to lucerne, clovers, and leguminous plants.

14. Lime will not act if phosphates are deficient.

15. It increases the need, everywhere present, of ploughing in green manure or stubbles.

16. It facilitates this operation.

17. The surest method of determining the need for lime is to dress trial strips and await results.

In an article on "Lime for Orchards," MR. P. J. CARMODY, Chief Orchard Supervisor, dealing in a practical manner with the effect of lime on fruit and fruit trees, and advocating its use, writes:—

"When it is considered that the average crop of fruit requires more plant food for its development than an average crop of wheat, and, moreover, that the fruit demands the same soil constituents year after year, the necessity for a sweet and favourable medium for root pasturage is apparent; and as no other application is at all comparable to the influence of lime for this purpose, its frequent use is urgently required. It is a matter of common observation that the fruit-buds of trees grown on sour soils are of a weak or indefinite character, while the bark is harsh and dry in appearance and the growth more or less stunted. Under such conditions it is practically impossible to develop trees on the most profitable lines without first correcting soil acidity by the free use of lime in the same manner as requires to be adopted for other farm crops.

"In many parts of the State insufficient attention has been given to this feature of soil management in the orchards. Particularly is this the case where fruit is grown on heavy clay soils. In these soils fruit trees grow

through a lengthy period, so that a considerable quantity of immature wood is produced to the detriment of subsequent crops of fruit. Measures have not hitherto been adopted to definitely determine the actual effect of lime on the different parts of the tree; but investigations in other countries show that on soils rich in lime the wood is matured earlier and the fruit-buds are more stocky and robust than is the case with trees grown on soils deficient in lime. This is very apparent to anyone acquainted with the fruit areas of many parts of Gippsland and other places in Southern Victoria, and one is struck with the unusual prominence or length of the fruit-buds, the relative distance between the nodes, and the softness of the wood in these districts when compared with the same varieties grown in fruit centres known to possess lime in abundance."

It may not, however, be correct to assign these differences solely to the effect of lime, as other soil constituents bear an important part on the character of the tree and its fruit buds, particularly potash. It is generally recognised that the trees are not so manageable nor so prolific in bearing in soils where lime is deficient, and growers who have rectified this have had excellent results, though as artificial fertilisers were subsequently applied the same year, the relative value of the lime could not be ascertained. Though lime plays an important part in the apple and pear tree, it is in the stone fruits that its value is most apparent. It is a familiar fact that in soils rich in lime, stone fruit set their crops well, and are not so prone to cut off their fruit at the period of "stoning" as is otherwise the case. Where trees are making extensive wood growth with abundant foliage, there is but little doubt that the application of lime at the rate of 7 to 8 cwt. to the acre would be of pronounced benefit.—QUEENSLAND AGRIC. JOURN., VOL. XV., PART 5.

THE PHYSICAL INVESTIGATION OF SOIL.

In an article in a recent number of *Science Progress*, MR. B. A. KEEN has presented, in simple language, an account of the modern outlook upon the physical investigation of the soil. In general, he says, the physical study of the soil may be expected to give results which are capable of application in two directions: firstly, to elucidate the reasons for the comparative advantages of the many forms of cultivation operations employed in farming practice; and, secondly, to supply information to the biologist on the physical environment in which the plant roots, insects, and micro-organisms exist in the soil.

Historically, soil physics has grown up in two definite periods. When the scientist first turned his attention seriously to agricultural problems, there were many obvious phenomena the investigation of which promised definite information about the various factors controlling plant growth. There were, for instance, questions of water supply, of the amount of available water in different types of soil, of the manner of its distribution over the minute soil grains, and so on. Early in the nineteenth century, DAVY, in the course of a series of lectures under the auspices of the newly formed Board of Agriculture laid stress on the importance of the physical properties of soil, while SCHUBLER in Germany, and BOUSSINGAULT in France laid the foundations of the subject in a series of classical experiments.

They regarded the soil as a framework of mineral particles of all shapes and sizes, something like a heap of sand, and considered that the soil moisture was spread over these particles in the form of a thin film. The movement of the water in the soil was controlled by the force of gravity capillary attraction in the minute pore spaces between the grains, evaporation from the soil surface, imbibition by plant roots, and so on. The well-established principles of pure physics were directly applicable to a soil of this type, and it was rightly concluded, from the methods and evidence then available, that a fairly complete survey of soil physics had been made. This was the first historical period, which closed about the year 1850.

At this time the famous researches of LAWES, GILBERT and WARRINGTON at Rothamsted, and LIEBIG in Germany, directed world-wide attention to agricultural chemistry, and soil physics fell into the background. A small amount of work was still done, however, by agricultural chemists and others, who found that the solution of a particular problem demanded some knowledge of the physical environment in the soil.

The opening of the second historical period may be dated from 1900, when WARRINGTON published a monograph on the physical properties of soil. He discussed in detail the knowledge obtained from the old water-film and sand-grain hypothesis and indicated certain soil characteristics whose explanation demanded at least an extension of this hypothesis. This extension was first given, apparently, by J. DUMONT in France, who assumed the soil particles to be coated more or less completely, with a film of jelly-like colloidal materials, derived both from the mineral material of the soil and from the organic residues of plants. We are hardly more than at the beginning of this second historical period, but sufficient results have already been obtained—first of all in Germany, later in England and America—to show quite definitely, that the colloidal theory, which has extended into so many different branches of science, will be of the greatest use to the soil physicist in his study of the very complicated physical constitution of the soil.

Generally speaking, sandy soils can be subjected with impunity to cultivation at times when clay soils would be seriously injured by similar treatment. This injury shows itself in the destruction of the soil tilth : the friable and porous surface, characteristic of good tilth, gives place to one which is sticky, and practically impervious to water or air, and which can be brought back only slowly into a better condition.

Although these two states of clay present obvious differences to visual inspection, and can be readily controlled by the farmer, very little is known about them. The grains in a soil in good tilth are loosely attached to each other, forming small porous aggregates, or compound particles, which may be likened in some ways to sponges. The formation of these aggregates from the individual particles is closely parallel to the flocculation, by acids and salts, of clay suspended in a bulk of water. Lime is used in practice to improve the physical condition of soils, and also produce flocculation of a clay suspension in the laboratory. One of the most important of the immediate applications of the colloidal theory, is the investigation of the jelly-like material supposed to exist on the surface of the soil, for it is the forces associated with this coating which control the aggregation of the ultimate particles, and are thus responsible for the production of good tilth.

The characteristic open structure associated with good tilth promotes a free exchange between the soil gases and the ordinary atmosphere, and certain investigators have been led to the conclusion that this is the essential feature in healthy plant growth. HOWARD and his collaborators, working mainly on the indigo plant in India, have attributed extreme importance to effective soil aeration. There can be no doubt that the development of soil physics, now taking place under the impetus of our increasing knowledge of the colloidal state of matter, will lead not only to a scientific understanding of the fundamental phenomena in soil cultivation, but will open up many possibilities of improvement.—AGRIC. NEWS, Vol. XX, No. 498.

SOIL PROBLEMS.

The application of modern physical chemistry and of modern methods of physico-chemical research to the study of the soil has become, of late years, the most promising line of investigation of those problems which deal with the relations of the growing plant with the soil in which it grows. A discussion of these methods and a survey of the present position were the objects of a meeting organised by the Faraday Society and held under its auspices in London on May 31. The meeting was well attended, and all those interested in soil science must feel a debt of gratitude to the Society for its recognition of the importance of the subject and for thus affording an opportunity for discussion. No fewer than fourteen papers were on the programme, covering almost every field of modern soil investigation dealing with the physico-chemical side of soil problems. It was a happy thought which prompted the Society to ask SIR DANIEL HALL, to whose inspiration, agricultural science in this country owes so much to preside at this meeting. DR. E. J. RUSSELL, the Director of Rothamsted Experimental Station, opened the discussion with a general review of the whole subject and with a brief statement of those problems which are in most urgent need of solution. He pointed out how it was convenient to regard the soil as consisting of mineral substances, which constitute a structural framework, with organic material and inorganic colloids forming a kind of clothing to this structure and, superimposed thereon, moisture from which the plant draws the water and the nutrient substances which it requires. The importance of the colloidal clothing in determining the condition of plant-growth has been insisted on more and more of late years, and there has been a tendency on the part of some investigators to assign to these colloidal substances many of the properties of soil which could not easily be accounted for in other ways. It has long been a matter of common knowledge that, under certain conditions, additions of calcium carbonate to soil make it kindlier and easier to work, and it is interesting to learn that exact experiments made to determine the resistance of the soil to the passage of the plough show a very considerable reduction in favour of soil which has been chalked. A pleasant feature of the meeting was the contribution of papers by foreign scientists, and the presence of one of the most active and most successful of the soil investigators of the present day, PROFESSOR ODEN of Upsala, and his description of his own work, were much appreciated.

PROFESSOR SVEN ODEN'S work upon humus is well known, and from it it appears that the existence of a definite humic acid as a portion of the humus of the soil is certain, though it is doubtful whether it is in any way harmful to crop plants. This is, of course, a doctrine which is in opposition to all the older views, and really means that the existence of this acid is not the controlling factor in plant development in sour soils. A large portion of the discussion took place on the question of soil acidity, and it was clear that, while we are still very far from understanding the whole conditions associated with acidity, considerable strides have been made in that direction, and in the direction of the simplification of the problem. Probably none of the subjects discussed possesses greater practical importance, as the correction of acid conditions is of the greatest moment from both an agricultural and a horticultural standpoint. Many practical problems await solution: the reason why a soil which has been limed, and has lost its lime, shows signs of greater acidity than a soil which has never had lime on it, the continued fertility of soils with a minute trace of calcium carbonate; these and many more are still obscure. The evil effects upon the soil of acid humus, which may result in the formation of iron pans in certain soils, are probably of much more general occurrence than is usually supposed. As was pointed out by those present who were not concerned with the investigation of soil problems, the one feature which was common to all the papers read, and to the remarks of everyone present, was the complexity of the subject. The soil-complex is not a simple system of soil and soil-water but an exceedingly complicated one, consisting of an infinite gradation of the mineral particles intimately associated with various kinds of colloidal material and with a dilute solution of a large number of different substances. It has also to be studied in its association with perhaps the much more complex system provided by the microflora and fauna of the soil and the growing crop plant. It was urged, and with much plausibility, that our knowledge of this complex will be much simplified if we can disentangle the problems, and investigate them to start with upon materials which chemically and physically are comparatively simple substances. Important as the discussion has been in clearing the ground and in demonstrating how very many of our older views on soil will have to be discarded in the near future, it has made us realise further how almost completely ignorant we are of the many factors which control plant growth. One word of warning was uttered by SIR DANIEL HALL. The object of this type of investigation must be the improvement of agriculture and horticulture, and a more economic utilisation of the resources of the earth. The zeal of investigators sometimes leads them to forget this; it is important that they should have it always before them. Discussions of this kind can do nothing but good, and it is to be hoped that it may be but the beginning of many such, as the cause of the three great branches of soil utilisation, agriculture, and forestry will be most profitably served thereby.—GARDENERS' CHRONICLE, VOL. LXIX No. 1799.

THE STORAGE OF ARTIFICIAL MANURES.

A correspondent has raised the question as to how long various artificial manures may be kept stored in a dry place without losing effectiveness. With the exception of superphosphate most artificial manures could be kept indefinitely if the conditions of storage were sufficiently good. In practical circumstances, however, the conditions are more or less defective, and trouble arises owing to the absorption of moisture.

Basic Slag is very little affected by storage, and can be kept almost indefinitely in a reasonably dry shed or store.

Sulphate of Ammonia is somewhat more easily affected by atmospheric moisture, especially if it comes from small gas works where it has not been well finished. The well-made neutral sulphate, however, is less affected. In any case the material is best stored in bags placed on planks or on a layer of peat rather than on the bare earth or brick floor. It may cake somewhat on storage, and should then be broken up with a wooden crusher.

Nitrate of Soda, Kainit and Sulphate of Potash.—These substances will keep indefinitely under dry conditions, such as the merchant's store; they may also be preserved for a long time in a well built shed on a farm. They undergo no inherent deterioration, but they may become lumpy through the action of moisture, and must then be crushed. There is no practical limit to the length of time the above fertilisers may be kept so long as the conditions are suitable.

Superphosphate is in a rather different category, and undergoes slow change on storage, which up to a certain point is advantageous. Well made samples in good condition have been stored for the necessary time by the makers; but prolonged storage may cause deterioration to set in. On the whole it is advisable to avoid the necessity of storing by careful calculation of the requirements and by using early in the following season any material that happens to be left over.

Nitrate of Lime cannot easily be stored once the package has been opened, as it is liable to absorb moisture in damp situations.

Ground Limestone can be stored indefinitely, either in bags or in bulk; but *lime* cannot be stored in bags, again because of its great power of absorbing moisture.—JOURN. OF MINISTRY OF AGRICULTURE, VOL. XXVIII, No. 3.

ORGANIC MATTER FOR THE SOIL.

Where corn was grown continuously equal yields were obtained with legumes and a half stand of rye as cover crops, the former requiring less supplementary nitrogen. A considerably larger yield of corn was produced on soil which had received all except nitrogenous fertilizers for 20 years and on which a sod containing clover was plowed under. The addition of nitrogenous fertilizers only slightly increased the yield,

On the basis of equal additions of organic matter, much composted with slaked lime gave as good yields of cabbage and late beets as stable manure, but gave smaller yields of lettuce, tomatos, celery and fall spinach.

Stable manure gave better yields of celery and tomatos than green manure and chemical fertilizers and about the same yields of cabbage the following spring. Stable manure alone produced better yields of sweet corn than complete fertilization with chemical fertilizers, Fall plowing of sod gave only slightly better results than spring plowing for potatos.—EXPT. STN. REC., Vol. 44, No. 1.

PESTS AND DISEASES.

RED RUST ON TEA.

The following address was given by the Government Botanist and Mycologist MR. T. PETCH, B.A., B.Sc., to the Sabaragamuwa Planters' Association on August 23rd, 1921 :—

The appearance of bushes attacked by Red Rust is perhaps only too familiar to some of you in this district. The bushes are thin ; the younger branches are weak and spindly and bear very few leaves. Sometimes the leaves gradually fall off, buds are produced which do not develop, and the twigs die back. The green twigs turn grey and harden prematurely. One fairly common and conspicuous effect is the occurrence of variegated leaves,—green and white, or green and yellow,—more particularly towards the outside of the bush. If the affected stems are examined, they will, at least in wet weather, be found to be covered with minute red hairs, which are sometimes so numerous that the stem appears red.

It is to be noted that variegated leaves are not invariably a sign of Red Rust ; green and white leaves may occur on healthy tea bushes. This effect is known as Chlorosis and in general it is not due to a parasitic disease. In the variegated leaves on bushes attacked by Red Rust, the white area usually shades off into the green, whereas on the other variegated leaves it is usually fairly sharply defined,

When bushes attacked by Red Rust are pruned, the disease may appear on the pruned branches. If, as in the Indian practice, a few inches of red wood, which has developed since the last pruning, have been left, these stems may become covered with the red hairs, and die back to the main branches. In Ceylon, when the bushes are pruned back to the old main branches, an inch or more in diameter, Red Rust may appear on these in an almost continuous covering extending from the pruning cut backwards for a length of six inches or more : as a rule these affected branches do not produce any new shoots, but die back.

Red Rust is unique among Ceylon plant diseases, in that it is caused by an alga, not by a fungus. I apologise for inflicting the technical name alga upon you, but there is no other word which can be used. The average individual when asked what an alga is will tell you it is a seaweed, and probably a dictionary will give you the same meaning. But although seaweeds are algæ, there are other algæ which live in fresh water, and yet others which live on damp earth or any damp surface. The green stains formed on walls exposed to wet, or on the trunks of trees where the rain water runs down are caused by minute algæ. In all cases they require abundant moisture for their development.

In the tropics, especially in districts with a heavy rainfall, algæ find conditions very favourable, and are able to grow in situations in which they do not occur, or only occur rarely, in temperate countries. Hence we find that a large number of species grow on leaves. The majority of these are harmless, as are algæ in general, but a few of them are parasitic and amongst these is the one which causes Red Rust.

The Red Rust alga belongs to a group which have orange coloured cell contents. To the naked eye it appears red. There are two forms which occur on tea leaves, one of them superficial, and the other within the tissue of the leaf.

The superficial form appears on the leaf, usually on the upper surface, as a small red circular disc. When it is examined with a lens, it is seen that the disc is not continuous, but consists of a number of sectors radiating from a central point. Sometimes, some of the sectors are missing, and the alga is then more or less star-shaped. From the surface there arise a number of hairs. These hairs are of two kinds. One kind ends in a point: these are barren hairs. The other kind are inflated at the top, when they bear several peculiarly bent cells, and each of these cells produces a spore case or sporangium. Spores are formed inside the sporangium. When they are ripe, the sporangum falls off, or is blown off, and, if it falls on a moist surface, it bursts and liberates the spores. Each spore is provided with two fine threads, or cilia, by means of which it can swim about in a film of water. If the sporangium has fallen on a leaf under favourable conditions, it liberates the spores, which germinate and grow into the typical red disc. This form does not penetrate into the leaf, and is therefore comparatively harmless. It has, however, some effect on the leaf, as the leaf cells underneath it become brown. In the case of thin leaves, the browning may extend right through the leaf. The second form has the same hairs and sporangia, but its development is quite different. When the spore germinates it produces a filament which penetrates into the leaf. It causes at first a watery green, or more or less translucent spot, and in some cases this spot has the same radiating form as a superficial alga disc. These translucent spots are known as oil spots in Java. . . . . The spot soon becomes more or less circular, and blackened and sunken. It is then visible on both sides of the leaf, and has usually a purple margin on the upper side, and a watery green margin on the lower. The alga is entirely within the leaf, chiefly beneath the epidermis. Ultimately it ruptures the epidermis, and produces tufts of hairs on both sides of the leaf.

It has been customary to regard these two forms as forms of the same species. That is, it is all the same alga, which is sometimes parasitic, living inside the leaf and destroying it, and sometimes epiphytic, i.e. merely living on the surface of the leaf without obtaining any nourishment from it. From what work I have so far been able to do on the subject, however, it appears to me that these two forms are two distinct species, an epiphytic species, *Cephaleuros mycoidea*, which is harmless, and a parasitic species, *Cephaleuros parasitica*, which is responsible for the damage done to the tea bush by Red Rust. But much more work is necessary before that can be decided.

The epiphytic form, that is, the red disc, does not cause any serious injury to the leaf, and its effect is negligible. The parasitic form kills the leaf in patches, but the leaf is not completely killed by it as a result of those patches. But if it attacks the leaf at its junction with the stem it may cause the leaf to fall. This appears to happen frequently. The spores of the alga when it first attacks the bush may lodge in the angle between the leaf and the stem and produce a primary infection there, or, if the alga first attacks the middle of the leaf and causes a diseased spot there, the spores from that spot are washed down by the rain to the base of the leaf and cause a secondary infection there.

However, if Red Rust was continued to the leaves of the tea bush it would not be a very serious disease. The trouble arises from the fact that it attacks the stems as well. The spores from the leaves are blown, or washed down by the rain, on to the stems, and if the stems are damp, the spores germinate and attack them. On the young green stems, the effect may be the same as on the leaf, that is, the first sign of infection is a watery green area, which subsequently blackens and produces clusters of red hairs. In general, however, the first evident sign is a premature hardening of the twigs, which usually turn grey in patches. This grey layer is the dead epidermis of the twig. It may have died after the alga has penetrated into the stem, or it may have been killed by the alga without actual penetration. Probably in the latter case, the alga penetrates subsequently. Ultimately the alga produces its fructifications, which cover the twig with red hairs, sometimes so numerous that the twig appears red.

If the spores fall on the red wood, they lodge in the minute cracks which usually occur in the rough outer bark layer of the stem, and on germination the alga filament penetrates into the living tissues. It ramifies between the cells of the bark and pushes them apart, with the result that the cells die. The effect of the alga extends beyond the extent of its penetration and thus a layer of dead cells is formed, between the alga and the living tissue of the branch.

Now if the bush is growing vigorously, it may form a cork layer beneath the layer of dead cells, which cuts out the dead tissue and the parasite with it. In that case the alga dries up and dies, and only a small scar is left on the branch. But if the bush is weak its growth proves too slow to admit of that, and the alga grows through the layer of dead cells, and kills off more, ultimately in many cases killing the branch.

That is the fact which supports the conclusion that Red Rust is a disease of weak bushes. The alga is universally distributed, but it does not become a serious parasite unless the bushes are, for some reason or other, not in a vigorous condition. If the bush is growing vigorously it can resist the attack of Red Rust.

Red Rust is not a new disease. It has been known in Ceylon for nearly twenty years, and in India for forty years. In India, it was under investigation for about ten years, and the main facts concerning the disease are well established. As in the case of all diseases, there are outstanding points to be cleared up, but in general they are not points which are likely to affect methods of treatment. It was a serious disease in India at the beginning of this century, and consequently special attention was given to it there. As a result of those investigations it has been decided that Red Rust is a disease which is only serious on weak bushes, and the methods of treatment adopted have been based on that conclusion. The methods recommended are successful and there does not appear to be any reason for disputing that decision.

Weakness of the bushes may be due to several causes, lack of drainage, shallow soil, the formation of a hard pan, improper plucking or pruning, or want of manure or cultivation. In general, the cause must be looked for in soil conditions.

The present occurrence of the disease in the Ratnapura district began in 1918. In 1919 the disease was fairly common, and attention was directed to it in the Annual Report of the Mycologist for that year, and in the Annual Report of the Planters' Association.

Some of the factors which favour an attack of Red Rust may be looked upon as local factors, i.e., factors which can only influence a comparatively small area,—for example, lack of drainage. In the present occurrence the disease is widely spread, and, if the controlling factor is the same throughout, we must look for a more general one. That, I think, is to be found in the reduction of manuring which occurred during the War. In the report for 1919 I intimated that the shortage of manures was beginning to show its effect by the prevalence of Red Rust, and that, I believe, is now the case. Whether the bushes have been further weakened by overplucking during the same period I leave to you.

The general treatment of fields attacked by Red Rust must be increased manuring. I would add increased cultivation, if necessary, but I am given to understand that cultivation has been carried on, rather with an idea that it would compensate for manuring.

Bushes should not be allowed to run up before pruning, with the idea of strengthening them. If they are allowed to run up they produce a large number of shoots which compete with one another and are weak in consequence. Nor should they be cut over with the idea of avoiding weakening the bush, as that leaves the weak outer branches. In either case the weak branches are more liable to be attacked by Red Rust. The bushes should be clean pruned.

In India, it is recommended that fields affected with Red Rust should be manured immediately after pruning with a mixture of 1 cwt. Ammonium Sulphate, 1 cwt. Superphosphate, and ½ cwt. of Potassium nitrate for light soils, or with 1 cwt. Basic slag and 1 cwt. Potassium nitrate for heavy soils.

You will note the recommendation of Potash in either case. During the war there was a tendency to regard the recommendation of potash as a German trade boom. They had the goods, and boomed them for all they were worth. And there is still a tendency to maintain that view. But, although potash was the subject of a remarkably vigorous propaganda, it does not follow that there was nothing to support it. Mycologists are agreed that manuring with potash, in general, diminishes susceptibility to disease. In the case of tea there is no doubt that it favours the development of wood and, although the crop is a leaf crop, you cannot have leaf without a framework to produce it. Red Rust is a serious disease only when it attacks the stem. Hence it is necessary to adopt methods which will favour the growth of wood. It may be noted that Branch Canker is again becoming prevalent on low-country tea. That is another sign of lack of Potash.

Theoretically, Red Rust, being due to an alga, should be readily amenable to treatment by spraying. Spraying unpruned tea, however, is scarcely practicable. Moreover, there is a special difficulty in spraying in the case of Red Rust, because the minute hairs make the patches on the leaf or stem velvety, and consequently it is difficult to wet them. It has been found that after spraying the red patches on the leaf may be still alive, or killed only round their edges. But spraying pruned bushes is a different matter. As I have already stated, after pruning, Red Rust may attack the main stems of the bush and kill them back. It would appear, though the point is not yet proved, that the spores of the alga are already present on the stems before the bushes are pruned, and that they develop later. If the pruned

bushes are sprayed, before the red hairs develop, there is no difficulty in wetting the branches, and the spores of the alga are killed. When bushes which are severely attacked with Red Rust are pruned, they should be sprayed after pruning with Bordeaux mixture.

There is no cheap and easy treatment of Red Rust. Treatment means money, and at the present time, unfortunately, money is scarce. Cheap treatments, such as burning over affected areas, light pruning, collar pruning, have been tried and found unsuccessful. All these leave the soil conditions as they were, and no improvement can be expected unless the deficiencies in the soil are rectified. On the other hand, the methods I have indicated, viz., manuring, especially with potash, and spraying bushes after pruning, combined with manuring, have been successful.

There is some confusion attending the application of the name "Red Rust." The name is really a misnomer, as the term "Rust" ought to be restricted to diseases caused by a certain class of fungi, the Uredineæ, to which the fungus of the coffee leaf disease belongs. However, the name "Red Rust" was given to this algal disease of Tea in India, and its use for that disease is now firmly established. But in some districts in Ceylon, it has lately become the practice to refer to attacks of Scarlet Mite, or other mites, on tea as "Red Rust." That is a mistake, and, as it leads to misunderstanding, that application of the name should be dropped.

PLANT PESTS AND DISEASES IN CEYLON.

PROGRESS REPORT OF THE DIVISION OF BOTANY AND MYCOLOGY FOR 2nd QUARTER, 1921

Correspondence

The number of in letters was 555 and out letters 426. Compared with the numbers for the first quarter, viz. 376 letters in and 305 letters out, this shows an increase of 44 per cent. which is probably to be explained by the fact that the first quarter of the year usually entails less work owing to weather conditions.

Investigations.

The number of specimens sent in for examination during the second quarter was 225, consisting of 141 specimens of diseased plants, 45 specimens of fungi for identification, and 39 specimens of flowering plants for determination.

In the first quarter of the year, 195 specimens were sent in, 132 being diseased plants, 12 specimens of fungi, and 51 specimens of flowering plants.

Of the diseases sent in during the second quarter, 38 were tea and 59 Hevea. This contrasts with 53 tea and 37 Hevea in the first quarter. The other specimens of the second quarter include Albizzia, Brinjal, Coffee, Cacao, Caryocar, Cedrela, Coconut, Colacasia, Crotalaria, Dadap, Grevillea, Hibiscus, Mango, Orange, Papaw, Pine-apple, Plantain, Poinciana, Rice, Sugar-cane, Sorghum, Tephrosia, Tobacco, Violet.

Of the Hevea specimens, 37 were cases of root disease, viz., 19 *Fomes lignosus*, 12 Brown Root disease, 3 Ustulina, 2 Xylaria, and 1 Diplodia; the Xylaria is practically a new disease: a single case was found in 1909, but none have been seen since.

In the tea specimens 14 were cases of root disease. These included 5 cases of Diplodia, and one each of the rarer root diseases caused by *Fomes applanatus*, *Polyporus mesotalpæ*, and *Polyporus interruptus*.

Examination of diseased tea seedlings showed that the "bitten off" disease, i.e., the disease in which the young roots appear to have been bitten off, is probably due to a Rhizoctonia. Another Rhizoctonia was found on young shoots from collar-pruned bushes which were attacked at ground-level and ringed. Further work is necessary in both cases to establish the parasitism of these fungi and determine their identity.

An undetermined leaf disease of tea, which was first reported about 1914 occurred again during this quarter. It has only been recorded from up-country districts. The young unfolded buds are attacked. These may blacken and rot completely, but more usually they blacken in patches. In the latter case, the bud develops, but the expanded leaves are perforated with irregular holes, or variously scalloped round the margin. This effect is due to the fact that the unattacked part of the leaf expands, while the diseased part dries up and falls out. The disease does not appear to advance further after the affected leaf has expanded. No fungi have been found in the diseased buds, but there is some evidence that the disease may be caused by bacteria.

Death of dadaps has been reported from two districts. In one case, plants grown from cuttings for green manuring are concerned, and in the other, well-established shade trees. It is not possible to take up investigations in this subject under present conditions.

A disease of Sorghum, new to Ceylon, has occurred on the Experiment Station, Peradeniya. This attacks the head, and resembles the common "wet weather mould" *(Cladosporium)*. It is caused by a similar fungus, *Acrothecium lunatum*.

Another disease, new to Ceylon, which also occurred on the Experiment Station, is Collar Rot of Sugar-cane, caused by *Hendersonina Sacchari* Butl.

A wilt of young Brinjal plants was determined to be caused by *Bacillus Solanacearum*.

The Assistant Botanist and Mycologist has continued work on the dwarf disease of plantains. Attention has been paid chiefly to occurrence of eel-worms and *Rhizoctonia*. As usual, it has proved difficult to get the *Rhizoctonia* into pure culture and until that has been done no definite conclusion concerning its pathogenicity can be arrived at. Another line of investigation is now being begun, and steps have been taken to establish plots of healthy plants for experiment.

The Assistant Mycologist has continued work on the diseases of coconuts and the Ceylon Phytophthoras. Another Phytophthora has been obtained from Nam-nam *(Cynometra cauliflora)* which may be identical with *Phytophthora Meadii*. Owing to the abnormally dry weather it has not been possible to obtain *Phytophthora* from coconut. It is evident that there are several causes, pathological or physiological, both of nut fall and leaf break, and attempts are being made to differentiate between them.

The Acting Field and Laboratory Assistant is making continuous observations on the occurrence of the teleutospores of *Hemileia* on coffee, and of the fructifications of Red Rust with regard to their dependence on

weather conditions. He has also determined the *Sorghum* disease caused by *Acrothecium*, and made examinations of the foot rot of Papaw, in addition to the usual routine of laboratory work.

The Assistant for Systematic Botany has assisted in the identification of phanerogamic specimens sent in, and in the collection of economic plants for critical determination. In company with the Plant Collector, he has visited Anuradhapura and Bibile to collect *Strychnos* and *Polytoca*.

T. PETCH,

Government Botanist and Mycologist.

REPORT OF THE DIVISION OF ENTOMOLOGY, APRIL TO JUNE, 1921.

The following is a summary of the Entomologist's report for second quarter of 1921.

The Entomologist visited the Batticaloa District in April to investigate the condition of the coconut cultivation in that area after the storm of January 1921, and to recommend measures for the control of the three chief coconut pests, namely, the Black Beetle (*Oryctes rhinoceros*), the Red Weevil (*Rhynchophorus ferrugineus*) and the Coconut Caterpillar (*Nephantis serinopa*). A report of this visit has been published, and the investigations are being continued.

About the middle of May the Entomologist and the Assistant Botanist and Mycologist took up the investigation of the insect pests and the diseases of plantains. Visits have been paid to some of the plantain districts. The weevil stem-borer (*Odoiporus longicollis*) and the weevil bulb-borer (*Cosmopolites sordidus*) were found to be prevalent, especially in plantations which are allowed to run more than two years without replanting. The work is being carried on.

Early in June the Entomologist paid a visit to two estates in Uva to investigate outbreaks of the Fringed nettle-grub (*Natada nararia*) on tea. This pest was found to be feeding on inter-planted dadaps, and on a number of other plants. Further details are being obtained as to the life history and habits of this pest.

Special investigations are also in progress on the following insect pests :—Tea termites (*Calotermes militaris* and others); Paddy Swarming Caterpillar (*Spodoptera mauritia*); the Spotted Locust (*Aularches miliaris*).

The following more important insects have been reported during the quarter :—Tea Tortrix (*Homona coffearia*); Rubber Stem and Root Borer (*Batocera rubus*); Paddy Stem borer (*Schoenobius bipunctifer*); Dadap shoot-borer (*Terastia meticulosalis*); Toona shoot-borer (*Hypsipyla robusta*); Mango fruit fly (*Dacus sp.*); Scale insect (*Ceroplastodes cajani*) on *Tephrosia candida*.

J. C. HUTSON,

Government Entomologist.

POULTRY.

POULTRY KEEPING IN PORTO RICO.

H. C. HENRICKSEN,

Specialist in Farm Management.

POULTRY ON THE FARM.

Those keeping poultry on the farm, or as a business conducted apart from that of farming, should bear in mind that the financial success of the undertaking depends upon (1) the keeper, (2) the bird, (3) the environment, and (4) the feed.

The keeper.—The woman of the house is usually in charge of the fowls on a farm, and the benefit to be derived from the poultry will largely depend upon whether she knows how to care for the fowls and whether she likes to do so.

The bird.—No amount of care will make a hen produce 150 eggs annually if she is but a 50-egg hen. In Porto Rico, as elsewhere, the profitable hen is the egg producer, not the heavy fowl which lays but few eggs. It should be the aim of every poultry keeper to get a setting of eggs from hens that are known to be good layers. If such eggs cannot be secured at once from improved breeds, selection should be made from the best hens in the keeper's own flock, or from the best available birds in the neighbourhood. How to select the best birds will be explained later.

The environment.—The average farm offers ideal conditions for poultry raising. The fields teeming with insects, newly cultivated soil containing worms, and the grain fields and the stables, are surroundings which greatly supply feed for fowls. In addition, outdoor life, with its abundant fresh air and sunshine, offers ideal conditions which tend to make fowls healthy and productive. However, it is absolutely essential that sanitation, housing facilities, egg boxes, and the like, be given very careful attention.

Feed.—Fowls may find insects, worms, and some grain, any or all of which may or may not be plentiful. Nevertheless, the farmer's wife must as carefully plan to feed her chickens as she does her children, and she must plan to produce the feed on the farm. A prime requisite which must be kept constantly in mind is that a hen can not produce the maximum number of eggs unless she receives all the feed she needs. It is not profitable to buy feed for the common hen, as she does not lay eggs in sufficient number to pay for it. In other words, the common fowl may be profitable when fed on cheap home-grown feed, but only the improved fowl can be expected to produce a profit when fed the expensive imported mixtures.

THE COMMON FOWL OF PORTO RICO.

In all countries there are chickens that do not belong to any particular breed. Such chickens are usually found on farms where poultry is merely a by-product. With the more progressive methods of farming, however,

the common chicken gradually disappears. In Porto Rico, where farming cannot be classed as progressive, it is quite natural to find that most of the chickens belong to no particular breed. The ordinary farm chicken, while varying in size, color, and productiveness, is generally small, a poor layer, and produces eggs below the average size. Since, however, this is the type of chicken usually found in Porto Rico, poultry raisers must do what they can to improve their stock until it can be replaced with better.

THE EGG BREEDS.

All of the egg breeds are small, active birds, good foragers, and therefore well adapted to the farm. In proportion to the amount of food they consume, the small birds produce more eggs than the heavier breeds, furthermore, unlike the heavier breeds, they do not become fat and lazy when penned up. The egg breeds are nonsitters, though occasionally a hen will become broody for a few days. The egg breeds have featherless shanks, a feature which makes them well adapted to muddy localities. These birds lay white-shelled eggs which are very large for small birds.

Most of egg breeds originated in the Mediterranean countries, where the climate is sub-tropical. Among them are the Leghorn, the Minorca, the Ancona, the Andalusian, and the Spanish. Another breed, the Campine, originated in Belgium. As far as the climate is concerned all these breeds are well adapted to conditions prevailing in Porto Rico, and all of them are much more profitable than the average native chicken. The actual value of one breed as compared with another can not be stated, as such valuation is not dependent upon the breed itself, but rather upon the development of strains within the breed. In fact, a high standard is obtained and maintained in any breed only by rigid selection and careful breeding.

VARIETIES.

Leghorn.—Of the several breeds above mentioned, the Leghorn is perhaps one of the best known. It is divided into varieties according to the color of its feathers. These varieties are white, brown, buff, black, and silver. Also there are the single comb and double, or rose, comb varieties. All of the varieties are of the same size, the full-grown male weighing about 5½ pounds and the female probably 4 pounds.

The single Comb White Leghorn has been bred to a very high stage of egg production. Theoretically speaking, any of the other colors are as desirable as the White Leghorn, but because more time, money, and energy have been expended in the development of this particular strain, it is one of the most highly bred birds in the chicken family. As to comb, there is no great difference. The single comb, however, is preferable in this climate.

Campine.—The Campine breed is also a very good egg producer. In many cases it equals and even surpasses the Leghorn, this depending, of course, upon the development of the strain from which the individuals come. The size is about the same as the Leghorn, the male being usually one-half pound heavier. The two varieties are the Silver Campine and the Golden Campine, the head and hackles of the former being white. The rest of the plumage is a greenish black, marked with white V-shaped bars. The Golden variet is the same, except that the white is replaced by golden bay.

Ancona.—This type of bird is very much like the Leghorn, the hen being about one-half pound heavier. The color is black, and some of the feathers are tipped with white in the form of a V. The two varieties, the single comb and the rose comb, are identical, except for the shape of the comb. The Ancona is probably the third choice among the egg producers for Porto Rico.

Minorca.—The Minorca is a larger bird than those of the three former breeds. In color it is either a shiny black, pure white, or buff, and has a single, or rose, comb. The Single Comb Black Minorca is the best known of the varieties and probably the most highly developed. The standard weights of this variety are: Adult male, 9 pounds; female, 7½ pounds. The Minorca has the advantage over the Leghorn, Campine, and Ancona in that it is larger and probably the most suitable for crossing with the common hen of Porto Rico. On the other hand, it is a heavier eater and does not produce as many eggs as the lighter breeds, considering the amount of feed it consumes, although it produces a very large pure white egg.

The other two breeds mentioned above, the Spanish and the Adalusian, are harder to procure and have no feature which would serve as a basis for their recommendation.

GENERAL-PURPOSE BREEDS.

The breeds discussed so far are small in size but are good egg producers. Another kind of bird which is not profitable in Porto Rico and therefore not to be discussed here is the extremely large type which is kept especially as a meat producer. There is, however, an intermediate type of fairly good size, the hen and cock weighing respectively 6½ to 7½ and 8½ to 9½ pounds. The hens, while good layers, are not usually as good as those of the well-bred egg breeds. . . . . The birds, in addition to being lazy are heavier eaters than those of the egg breeds, and may become too fat and lay but few eggs. This, however, is not so likely to happen with free range on the farm as where they are penned up. Of this type Plymouth Rock, Rhode Island Red and Wyandotte are the most important breeds in America. All three originated in the United States and are now readily obtainable in Porto Rico. These breeds have smooth yellow shanks, a feature which, under Porto Rican conditions, makes them desirable. Their eggs are brown-shelled, and, in every respect, as good as those having a white shell.

VARIETIES.

Plymouth Rock.—The Plymouth Rock is the most popular farm bird in the States. The six varieties are practically identical in every respect except color. The Barred Plymouth Rock, which is the best known and probably the most highly developed of the varieties, has grayish-white feathers, each crossed by dark bars. In color it is similar to a type very frequently found in Porto Rico, but the two are not to be confused. The Porto Rican barred fowl is practically identical with a type of the common fowls in the States which belongs to a distinct breed called Dominique.

Rhode Island Red.—Of late years this has become popular as a farm fowl in the States. The two varieties, one a single, and the other a rose comb, are red in color, as the name (Rhode Island Red) indicates.

Wyandotte.—The Wyandotte is a well-developed breed divided into eight varieties, all having a rose comb and being alike, except in color. The white is the most popular variety, and for that reason perhaps the most highly developed. Other varieties are : Silver, golden, buff, partridge, silver pencilled, Columbian and black.

THE GAME.

The Game is a breed very well-known in Porto Rico. It cannot be recommended as a domestic fowl, as it is not so good an egg producer as the Plymouth Rock or birds of that type, and is kept in Porto Rico merely for cock fighting.

HOW TO IMPROVE BREEDING STOCKS.

Inasmuch as the average farmer does not keep poultry as his main business the problem for him to solve is how to improve his flock at least cost. There are three methods of procedure : (1) To buy a setting of eggs, (2) to buy a few hens and a cock, and (3) to buy a cock only. To buy a setting of eggs is usually the cheapest method. However, as eggs from very choice flocks are expensive the cost may be high, unless all the eggs hatch and no loss among the chicks is experienced. Eggs shipped from the States will hatch after arriving here, reports to the contrary notwithstanding, but the present mail facilities prevent shipment of young chicks. To buy a few 6-months-old pullets and a cock is a perfectly satisfactory but rather expensive method. Birds from highly developed strains are always expensive, but it is wiser to pay a high price for a few select birds than to buy a larger number that will prove undesirable. The same rule applies when buying a cock only. Such a bird, if obtained from a conscientious breeder, may be cheap at 25, and if an individual cannot afford to buy it a community or a poultry club may do so. A choice male when mated with a flock of 20 hens, selected from the very best obtainable in the neighbourhood, will up-grade the stock in a very short time.

What breed to choose is so much of an individual question that it is difficult to give advice about selection. Undoubtedly on a poultry farm the most profitable bird is one of the egg breeds, since these are small and produce a large number of eggs in comparison with the little feed they consume. Feed is quite expensive in Porto Rico, and it pays to sell 9 eggs (1 pound) for 45 cents rather than live poultry at that price. On the average farm the heavier general-purpose breeds may be profitable, but even there the feed is by no means cheap. Moreover, the consumers are used to paying for poultry by the price and not by weight. For this reason it will be more difficult, at least for some years, to sell the larger birds to good advantage.

As a rule the most practical method of improving the farm flock is to buy a purebred cock of a selected strain of one of the egg breeds and to mate him with 15 to 20 hens selected from the best native stock obtainable. Eggs from those pens should be the only ones allowed to hatch, and from the progeny the most desirable hens should be selected. These hens should be mated with a fresh purebred cock, or exchanged with another poultry club. The principal fact to be borne in mind is that a purebred selected male should always be used, but never one that is either father or brother to the hens.

HOW TO SELECT BREEDERS.

As egg production is at present more profitable than meat production, the directions here given for selection of breeding stock are intended to enable the poultry raiser to secure the largest possible number of eggs from the hens of his flock. Selection is absolutely necessary regardless of the breed. Any strain quickly deteriorates without rigorous selection.

THE EGG TYPE.

The egg type is generally characterized by its long, graceful body. From the side, the neck and tail appear to be placed at an angle of 45° to the body. The back is long and straight. The breast is evenly curved from the head to the legs. The general appearance is graceful, never heavy or dumpy. The vigorous bird of any breed, and not the small, inactive one, should be selected.

HEAVY EATERS.

A hen of good egg type will produce eggs sufficient to pay for the feed she consumes ; she must, however, be a hearty eater, else she will not produce the maximum number of eggs. A hen may be compared with a machine used for manufacturing eggs. She is fed well, and in return is expected to be capable of giving the largest number possible of eggs.

EARLY RISERS AND LATE RETIRERS.

In order to observe these points, one must "get up in the morning with the chickens." To know the worth of hens which are to be used for breeding purposes the caretaker or poultry manager must know all about them. Hens which go to roost early in the evening and stay until late in the morning are not desirable types. The hen that fills the egg basket is the early riser and late retirer.

HEAVY PRODUCERS.

Production is the real test. A hen may be of the egg type, she may be large and vigorous, she may be a heavy eater and an early riser, and yet she may not fill the egg basket. Where there are large flocks of chickens it is impossible to determine the individual production of eggs unless one uses trap nests. On the farm, however, it is not an uncommon thing for the housewife and the children to know what the hens are doing.

PERSISTENT LAYERS.

The good egg producer is the hen that lays persistently and frequently. The hen that has frequent or long-continued non-laying periods is not the one producing 200 eggs a year. There are hens which produce as high as 300 eggs a year. Inasmuch as a hen cannot produce eggs and feathers at the same time, it is reasonable to conclude that the heavy producer has a short moulting season ; or, in other words, she starts to lay early in the season and keeps on until late. The hen producing eggs when eggs are high in price is, of course, the most profitable.

MATURE BIRDS.

Mature birds are the only ones from which to select. Pullet eggs should never be used for hatching. The value of a hen cannot be determined until she has been under observation for a long time. A pullet hatched early in the spring should begin to lay eggs in the fall. In that case she can be carefully watched until the next fall, when she begins to moult, and the spring after

that, when she begins to lay again. If she ranks in all the points discussed above, it is quite certain that her eggs will be superior to the average for setting. A keeper should not be discouraged if he finds but one hen in a whole flock, or even in a whole community, that grades high in all or most of the points mentioned. By hatching a few dozen eggs from that particular hen mated to a purebred cock, the keeper may expect in a few years a strain of chickens that will produce many more eggs than he now gets.

THE MALE BIRD.

The male bird should also be selected, whether it is purebred or mongrel. While it does not pay to use a mongrel male for breeding, this bird should, if used, be selected for egg type characteristics, the same as the hen. Under no consideration should a cock be used for breeding unless hatched from an egg laid by a selected hen. Where the flock is large an extra cock may be kept as a reserve, but otherwise all cockerels should be disposed of in the fall. It is a financial loss to keep them longer, as they have no influence upon the hens in regard to the number of eggs produced. The hens will lay as many eggs without the males, and the eggs will be of better keeping quality. The latter is of greater importance in Porto Rico than is generally realized. Eggs that are not fertilized will keep fresh for several weeks if kept in a clean, dry, and moderately cool place. Unfertilized eggs will also keep much longer than the fertile ones when a preservative is used.

KEEP YOUNG BIRDS ONLY.

A pullet hatched in April will usually begin to lay in November and continue laying through the winter. Next fall she will go through her first moult, and begin laying again sometimes during the winter. The following fall—that is, when she is 2½ years old– she should be disposed of. Many poultry keepers in the States dispose of the hens the second fall; that is, when they are 1½ years old. This, however, is not practicable on the farm. On the other hand, it is unprofitable to keep hens after they attain the age of 2½ years. That rule does not apply to breeders of course. They are frequently not selected until in the third year, and they may be kept for several years if their progeny is satisfactory.

SANITATION.

On the farm sanitation means ordinary cleanliness; that is, clean drinking water, clean roosting places, and clean nest boxes. The roosting places should be cleaned and thoroughly whitewashed with lime every month. The nest boxes should be cleaned and the contents burned. It is good practice to hold the box over a fire so as to scorch the inside and thus kill germs and insects. In Porto Rico, where tobacco stems and waste from tobacco factories can be obtained cheaply everywhere, there is no reason for letting the poultry suffer from insects. Tobacco stems should be substituted for straw in the nest boxes, and tobacco dust should prove as good an insect powder as can be bought anywhere. Nothing is better than grease containing a few drops of kerosene to drive fleas from the heads of chickens. Carbolineum, or crude petroleum, thoroughly applied to the roost the interior of the chicken houses, and to the nest boxes, is an effective treatment for mites and ticks.

In the commercial poultry yard sanitation is the all-important problem. Undoubtedly most of the failures in Porto Rico can be traced directly to improper sanitation. The temptation seems to be to keep too many birds

in one inclosure, or in several adjoining inclosures. This is a very dangerous and an unwise practice unless conditions are favourable and great precautions are taken. In the first place, the yard should be well drained, and the land made to slope so that the water will run off quickly. The fence should be of wire, not boards, and the fence posts should be of cement. The house should preferably be constructed of cement posts, with cement floors and galvanized-iron roofing. In addition the house and yard should be shaded by rather large trees. Where several pens are close together they should be so located that water from one cannot drain into another.

All pens must be carefully cleaned every week. The manure should be swept up and removed. The posts, roosts, etc., should be sprayed with a lime whitewash, and the ground should be well sprinkled with powdered lime. A sick bird should be promptly removed to an isolated pen, and a dead one should be immediately burned. In case of an epidemic the birds should be removed, each pen separately, to some new location, and their old pens should be disinfected with crude carbolic acid or some other strong disinfectant.

FEEDS AND FEEDING.

Most people keep poultry for the profits accruing therefrom. In calculating that profit on the farm, charge for caretaking is seldom considered. Therefore, consideration is given the cost of the feed only—that is, the feed actually supplied—and, in some cases, the cost of crops destroyed by the chickens. On the other side of the account are the eggs and the meat, and the difference between the two items is the gain and loss.

In the States a heavy bird such as the Plymouth Rock consumes from 80 to 100 pounds of grain per year when penned up. The egg breeds consume less, and especially so in this warm climate. On the farm the feed bill is not usually high because fowls pick up considerably in the field, and the feed supplied, if produced on the farm, is often such as would not bring much money when sold. There are two general classes of feed, one containing principally starch, such as corn and root crops and the other, containing a large proportion of protein, includes beans and other leguminous seeds, as well as meat and fish scraps. Both of these classes of feed are necessary for poultry, and both should be produced on the farm. One of the cheapest protein feeds is the pigeon pea, which can be produced anywhere in Porto Rico. It can be planted in the fence rows and in odd corners, and chickens will do the harvesting. Any of the legume, such as peas and beans that have been injured by rain and can not be cured, will serve for chicken feed. Offal from slaughter-houses is excellent, and fish scrap is also good as feed, but it should be fed sparingly or it will cause the eggs to have a fishy taste. In breeding pens where the eggs are used exclusively for hatching, the hens may be fed generously with fish. Fish or meat when fed to hens will start them laying, and tends to produce more eggs than other classes of feed. The egg is one of the most concentrated of protein foods, and no hen can produce the maximum amount of eggs without plenty of beans, peas, or animal matter. Corn is a good feed, but it produces fat when fed in large quantities. Root crops, which may be fed raw or boiled, are excellent when fed together with protein feed of some kind

The whole secret of obtaining profitable results is to supply much protein feed, and to mix it with other feeds so that the hens will like it and eat much of it. A good hen will pay handsomely for all the feed she eats. A 150-egg hen with eggs at $2\frac{1}{2}$ cents apiece on the farm, produces $3·75 per year. Even if she consumes a dollar's worth of feed, she brings a good profit.—CIRCULAR NO. 17 OF PORTO RICO EXPT. STATION.

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APICULTURE.

TALKS TO BEGINNERS ON BEE-KEEPING.

BY THE EDITOR, "GLEANINGS IN BEE CULTURE."

In the spring when conditions are favourable for brood-rearing, the bees will increase the amount of their brood with surprising rapidity until they may have as many as 10 to 15 combs fairly well-filled with brood. Such extensive brood-rearing does not last long, and many colonies do not reach more than seven or eight combs of brood, even at the height of spring brood-rearing. As this brood emerges the colonies soon become so strong that, if extra room is not given, the bees may not all be able to stay within the hive during warm nights, but may cluster in large masses on the outside.

This is the time that the instinct to swarm is aroused in the colony, and the period of most extensive brood-rearing in the spring is usually followed by swarming. Bee-keepers speak of this as the swarming season. While colonies may swarm later in the season if similar conditions are present, most of the swarming of the season occurs as a climax to the great expansion of brood-rearing in the spring.

HOW BEES PREPARE FOR SWARMING.

The rearing of drones is probably a remote and indefinite step in the preparation for swarming; but, so far as the bee-keeper is able to see, the first definite preparation the colony makes is that of starting queen-cells.

In some of the Southern States, queen-cells built preparatory to swarming may be found in some of the strongest colonies as early as March and April, but in the North they usually are not built until May or June. Queen cells are usually built along the lower edge of the comb and are so constructed that the opening of the cells is downward, thus making these cells nearly vertical instead of nearly horizontal, as are the worker-cells. Frequently partially built queen-cells or "cell cups," which are empty, may be found along the lower edge of the combs. These are sometimes built long before eggs are placed in them in preparation for swarming, and are therefore not necessarily significant as indicating a desire to swarm. Finally several of these cell cups are built and eggs are laid in them. This means that the colony is now definitely preparing to swarm unless the queen is old and failing, in which case it may mean that the bees are rearing another queen to take her place. With normal colonies having a normal queen, the starting of queen-cells means that a swarm may be expected to issue eight or nine days from the time the eggs were laid in the queen-cells.

The beginner can follow the entire programme as carried out by the bees, by watching the development of these queen-cells. Usually the swarm issues at about the time the more advanced of these queen-cells are capped—though Italian bees sometimes swarm earlier, and bad weather may compel the bees to wait until later.

PRIME SWARMS AND AFTER-SWARMS.

When the swarm issues under these conditions the old queen goes along, leaving behind the immature, young queens in their cells. Enough bees stay in the old hive to take care of the brood, which at this time is emerging so rapidly that the parent colony soon has quite a force of bees again. If the prime swarm issued on schedule time (when the first queen-cells were capped), an after-swarm may be expected from the parent colony about eight days later the after-swarm being accompanied by one of the recently emerged young queens. If the bee-keeper does not interfere to prevent it, usually several after-swarms issue, one coming out every day or two, until the colony is so depleted that there are no longer bees enough to divide up among the remaining young queens. Usually but one of these young queens is at large in the hive at a time, the others being held prisoners within their cells, though sometimes two or more young queens may go out with an after-swarm. Finally, when no more swarms can be sent out, all but one of the young queens are killed, the surviving one being destined to become the new mother of the colony.

SWARMING UNDESIRABLE.

If the bees are permitted to carry out their own programme completely as to swarming, it usually means a loss of the honey crop from the colonies that swarm, since the great army of workers which filled the hive to overflowing at the beginning of the honey flow is dissipated by swarming. The bees should not be permitted to divide their working force just before or during the honey flow, and the beginner must learn to prevent this.

CLIPPING THE QUEEN'S WINGS.

Preparatory to taking care of any swarms that may issue, it is advisable for the beginner to find the queen in each hive and clip off the greater portion of the wings on one side. This is to prevent the queen from flying when a swarm issues, thus giving the beekeeper control of the swarm if it should choose to cluster in the top of a high tree or fly away to the woods. The same control may be had by using a queen and drone trap, with the advantage that the trap automatically catches the queen; while, with a clipped queen, it is necessary to find her on the ground in front of the hive when a swarm issues. The ambitious beginner should learn to clip his queens however, and, in the northern States especially, now is a good time to do this,

TO PREVENT SWARMING WHEN PRODUCING EXTRACTED HONEY.

If extracted honey is being produced, the first super should be put on some time before the beginning of the main honey flow. In fact, if empty combs are available a super of empty combs should be given as soon as the brood-chamber is fairly well filled with brood, honey, and pollen. The queen-excluder should not be used between the brood-chamber and the super at this time, but the queen should be permitted free range through both stories. This should prevent early swarming.

If empty combs are not available for this first super, frames filled with full sheets of foundation should be used, but these should not be given until the bees commence gathering enough nectar to cause them to begin to build new white wax on the darker combs in elongating and repairing the cells. When foundation must be used some of the combs of brood from below should be placed in the middle of the second story. This affords an opportunity to place four frames of foundation adjacent to four combs of brood, two in the upper chamber, and two in the lower chamber. As soon as the bees have drawn out the foundation in these four frames so that they now really contain combs with shallow cells, these newly built combs can be moved toward the side of the hive, and other frames, which the bees have not yet worked on, put in their places. These new combs are built out better in the second story, and it is well to have most of this work done there.

As soon as new honey is being stored fast enough so that the second story is nearly filled with brood and honey, another super should be placed on top of the hive, making it three stories high. If empty combs are available, eight of these may be used in this 10-frame super, the combs being spaced farther apart so each comb will hold more honey; but, if foundation is used, the frames should not be spaced so wide until after the combs are built out. When foundation is used in the second super, at least two combs from the first super should be placed in the second super to induce the bees to begin work there promptly.

About a week after the beginning of the main honey flow or after the queen has abandoned the lower story long enough so that the brood there has all been sealed, the queen should be put down into the lower story and confined there by a queen-excluder, which should be placed between the first and the second story. The queen will usually be found in the second story at this time. To find her, lift off the third story if one is on the hive; then, without smoking the bees in the second story more than necessary, lift it off and set it on the inverted hive cover in such a manner that the bottom-bars of the frames do not touch the rim of the cover, to avoid crushing bees. By examining these combs one by one, the queen should be found, picked up by the wings, and placed in the lower brood-chamber.

In reassembling the hive after the queen has been put down, the queen-excluder should be placed over the lower brood-chamber; the super which was formerly the third story should be put on as the second story; and the former second story, which contains most of the brood, should be put back on top as a third story. If more room is needed at this time, an additional super may be given, in which case the former second story, being placed on top, now becomes the fourth story.

Ten days later it may be well to destroy all the queen-cells that are built in this top super, though this is not always necessary.

Colonies treated in this way usually do not swarm if additional supers are given as fast as needed, though they may do so if the honey flow is long,

TO CONTROL SWARMING WHEN PRODUCING COMB HONEY.

When producing comb honey, the first super should be given when the bees begin to add new white wax to the old dark combs in the brood-chamber. The sections in the comb-honey super should contain foundation, preferably full sheets filling the sections almost completely. If possible, the first super should contain at least one section in which the comb is already built, saved over from the previous year. This "bait" comb should induce the bees to begin work in the first super promptly. As soon as the bees commence working on the outside sections of this first super, a second super should be given. If the bees are working well and new honey is being stored throughout the first super, the second super should be placed below the first one; but, if the bees are not working in all sections of the first super, the second super should be placed on top of the first one.

HOW TO HIVE A SWARM.

If a swarm issues look for the queen (if she has been clipped) on the ground in front of the hive while the swarm is coming out. When the queen is found put her into a Miller queen-catcher and introducing cage or any kind of wire-cloth cage in which she can be confined. Lay the cage down near the hive in the shade; then move the hive from its stand, turning the entrance to one side. Place a new hive where the old one stood, having frames filled with full sheets of foundation, and, if available, one empty comb. Transfer the supers from the old hive to the new, put back the covers on both hives, and thrust the cage containing the queen into the entrance of the new hive.

The bees may return and enter the new hive without clustering, or they may cluster and return later. As they are returning none of them should be permitted to enter the old hive. To prevent this, it may be necessary to cover the old hive with a cloth or move it farther away. When most of the bees have entered the hive the queen should be released among them.

If a queen trap is used to catch the queen as the swarm issues, instead of clipping the queen, the procedure is the same except that it is not necessary to look for the queen; but after the swarm is out, the old hive set to one side and the new one is in its place, the queen trap may simply be put on the new hive and the slide pulled out to permit the queen to enter the hive when the swarm returns.

After the swarm has entered the hive and the excitement has subsided the entrance of the parent hive should be turned toward that of the swarm.

A day or two later the parent hive should be turned with its entrance close to that of the swarm, and on the seventh day, choosing a time when the bees are working well in the fields and preferably early in the afternoon when many young bees are taking their play flight in front of the parent hive, it should be moved to a new location at least 20 feet away for increase. In moving the parent hive away it should be handled carefully to prevent disturbing the bees, so that the field bees going out will not note the change in the location of the hive. When this is done most of the young bees, which have become field workers during the week, as they return from the fields will now enter the new hive on the old stand where they should be most useful, so depleting the parent colony of its bees that after-swarming is usually prevented; and since most of the workers are held together in the new hive on the old stand the yield of honey should not be reduced on account of the swarm having issued. Usually the parent colony does not produce any surplus honey the same season, but it should be in excellent condition for winter.

GENERAL.

AGRICULTURAL SCHOOLS IN ALBERTA, CANADA.

The following note has been communicated by MR. J. MCCAIG, Editor of Publications, Department of Agriculture, Alberta :—

The Province of Alberta, Canada, is becoming distinguished for its work in agricultural education, chiefly through the influence and work of the HON. DUNCAN MARSHALL, present Minister of Agriculture for the Province. MR. MARSHALL is a frequent visitor to the Mother Country and may be known to a good many readers of this *Journal*. In company with two other Canadian breeders he recently purchased a shipment of Shorthorns and Shropshires for his own farm.

Contrary to common practice, the Alberta system of agricultural education begins with a strong understructure rather than a heavy top, as represented by an agricultural college. All the provinces of Canada, in fact, are active in utilising a good body of agricultural material in connection with the elementary schools. This body is commonly referred to as "educational agriculture" rather than "material for agricultural education." A good deal has been accomplished in this elementary work in Alberta.

Both Boys and Girls.—MR. MARSHALL'S efforts relate specifically to the farm boys and girls after they have passed the elementary school age. The agricultural schools are administered by the Department of Agriculture, not by the Department of Education, and this gives them perhaps a closer touch with practice and application than they could possibly have as part of the general scholastic system. The schools are not integrated with the general educational system, but the work done in the agricultural schools, if students have sufficient general training for matriculation, counts in their university course at the college of agriculture. The outstanding service of the schools is that they give direct training to boys and girls who intend to go back to the farm. At present there are six of these schools in the Province, one-half of them having been opened in the autumn of 1920. It is expected that they will train upwards of one thousand boys and girls during the year. One of the schools during the last two years has done good work in training returned soldiers. The Minister has expressed his intention of making provision at these schools for special courses for British boys and girls who need to be taught something about western agriculture before going on the land. These would probably be summer courses and would include a combination of study and farm work.

Free Courses.—Pupils must be sixteen years of age; there are no academic restrictions and no fees for tuition. The course extends over two years and sessions are limited to the period between October and April. Courses for boys, and for girls likewise if they wish to take them, include field husbandry, animal husbandry, dairying, shopwork and machinery, horticulture, poultry-keeping, farm management, elementary farm economics

English and farm mathematics. The sciences underlying these subjects are part of instruction as far as they relate directly to practice. The schools have a number of improving organisations such as athletic, musical and literary clubs.

Classes for girls include cooking, sewing, nursing, household management, accounting, dairying, poultry-keeping and horticulture. They have instruction in the direct science such as bacteriology, chemistry, physics, etc., relating to practice. They also have English and mathematics and share in the benefit from the organisations for improvement and recreation. There are about six or seven teachers on the staff of each school.

Institutional Farms.—Connected with each school is an institutional farm called a demonstration farm. It is generally of a good size, consisting of not less than 320 acres, of which thirty acres are devoted to experimental work. The rest of the land is run like an ordinary farm with a manager and hired men, but it is under the direction of the head of the school for the purpose of ensuring that it shall exemplify farm practice of a high grade, based on the findings of the school. A good deal of attention is devoted to establishing conserving rotations, but this is not easy on parts of the prairie where grain growing is the chief business. The farms also serve for the raising of good seed and live stock, which are distributed to farmers at reasonable prices.—JOURN. OF MINISTRY OF AGRICULTURE, Vol. XXVIII, No. 3.

YIELD OF SISAL FIBRE IN JAMAICA.

The average annual yield of sisal fibre in East Africa, the Bahamas and other countries, is about one to one and a half tons per acre. The following figures, issued by the Director of Agriculture, Jamaica, and published in the JOURNAL OF THE JAMAICA AGRICULTURAL SOCIETY, indicate that the yields obtained at Lititz are somewhat below the average, though there must be taken into account, the fact that the soil at Lititz is of the poorest character subject to very dry climatic conditions :—

	Cut, November, 1919.	Cut, November, 1920.
Average number of leaves fit to be cut, per plant ...	32	30
Average yield of leaves in lb. per plant	19	18
Average weight of single leaf ..	9·6 oz.	9·7 oz.
Recovery of fibre (by hand) per cent.	3·4	3·93
Fibre per 1,000 plants in lb. ...	646	759
Yield per acre of fibre (6 × 5) at normal distance of (6 × 5) ..	938	1,029
Total	2 cuttings	1,967 lb.

These results are encouraging, as the drought at Lititz in 1920 has been very severe, and the experimental site is considered to be the most infertile area on the whole of the Lititz Savannah.—AGRICULTURAL NEWS, Vol. XX, No. 494.

ANIMAL DISEASE RETURN FOR THE MONTH ENDED 31st August, 1921.

Province, &c.	Disease	No. of Cases up to date since Jan. 1st, 1921.	Fresh Cases	Recoveries.	Deaths.	Balance Ill.	No. Shot.
Western	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	83	—	83	—	—	—
	Anthrax	—	—	—	—	—	—
Colombo Municipality	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	88	—	—	—	—	—
	Anthrax	—	—	—	—	—	—
	Rabies	2	—	—	—	—	—
Cattle Quarantine Station	Rinderpest	—	—				
	Foot-and-mouth disease	51*	—				
	Anthrax	325†	10				
Central	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	13	—	13	—	—	—
	Anthrax	—	—	—	—	—	—
	Piroplasmosis	12	5	7	5	—	—
Southern	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	35	—	35	—	—	—
	Anthrax	—	—	—	—	—	—
Northern	Rinderpest, Foot-and-mouth disease, Anthrax	Free					
Eastern	Rinderpest	—	—	—	—	—	—
	Foot-and mouth disease	241	57	183	9	49	—
	Anthrax	—		—	—	—	—
North-Western	Rinderpest	36	—	11	23	—	2
	Foot-and-mouth disease	—	—	—	—	—	—
	Anthrax	—	—	—	—	—	—
North-Central	Rinderpest, Foot-and-mouth disease, Anthrax	Free					
Uva	Rinderpest	—	—	—	—	—	—
	Foot-and-mouth disease	401	2	390	10	1	—
	Anthrax	—	—	—	—	—	—
	Hæmorrhagic Septicæmia	20	—	2	18	—	—
Sabaragamuwa	Rinderpest, Foot-and-mouth disease, Anthrax	Free					

* 7 cases occurred amongst sheep and goats. † occurred amongst sheep and goats.

E. T. HOOLE,
for Government Veterinary Surgeon.

Colombo, 3rd September, 1921.

METEOROLOGICAL.

AUGUST, 1921.

Station	Temperature: Mean Daily Shade	Temperature: Difference from Average	Mean Humidity	Mean amount of cloud 0=clear. 10=overcast	Mean Wind Direction during month	Daily Mean Velocity.	Rainfall: Amount	Rainfall: No. of Rainy days	Rainfall: Difference from Average
	°	°	%			Miles.	Inches		Inches
Colombo Observatory	81·2	+ 0·2	80	8·8	WSW	135	3·44	23	+ 0·80
Puttalam	82·3	+ 0·7	76	4·2	SW	278	0·42	3	- 0·33
Mannar	84·7	+ 1·5	72	6·6	SW	111	0·01	1	- 0·59
Jaffna	84·2	+ 1·5	78	4·8	SW	340	0·01	1	- 1·55
Trincomalee	85·2	+ 0·4	68	6·5	SW	216	2·20	5	- 2·03
Batticaloa	84·4	+ 0·4	72	6.2	Variable	124	3·38	9	+ 1·15
Hambantota	81·6	+ 0·3	77	5·4	WSW	397	1·35	8	+ 0·11
Galle	79·6	- 0·4	84	6·6	WNW	319	6·32	25	+ 0·94
Ratnapura	79·9	- 0·3	84	8·1	—	—	18·29	29	+ 6·62
Anu'pura	83·6	0	70	5·2	—	—	2·39	6	+ 0·56
Kurunegala	80·8	- 0·1	80	6·1	—	—	7·17	18	+ 3·81
Kandy	75·7	- 0·1	83	8·3	—	—	10 83	24	+ 5·36
Badulla	74·6	- 0·8	80	7·2	—	—	4·21	14	+ 0·98
Diyatalawa	70·0	0	73	6·6	—	—	3·91	15	+ 0·28
Hakgala	62·5	+ 0·9	84	8·1	—	—	5·71	20	+ 1·20
N. Eliya	61·1	+ 1·7	86	9·0	—	—	8 51	27	+ 0·68

During the first part of the month, and at the very end of it, the pressure gradient and wind were of quite the normal South West monsoon type with rain chiefly in the southern half of the island (though 1·14 in. was measured at Trincomalee on the 17th).

However from the 23rd to 29th there was a very definite fall off in the steepness of the gradient such as does not occur usually until much later in the year, and this brought its natural result in the form of local thunderstorms and wind deviations. The following examples are taken from this period:—Labugama recorded 5·15 in. on the 26th of which 3 in. fell in 45 minutes, while Avissawella and several other stations in that neighbourhood also reached 5 in. In the North Central Province at Maradankadawala there were 9½ in. in 5 days and towards the south east Udahena and Sudupanawela each received over 9 in. in 4 days. At Nuwara Eliya hail occurred on the 24th and 25th.

Numerical totals for the month, both of rain and number of wet days were above average at most stations. Excesses of more than 5 in. were common in the S.-W. quarter of the island. Elsewhere they were infrequent but were found at Matale, Maradankadawala and some stations in Central Uva.

The stations that failed to reach their average rainfall included most of those in the Northern Province, some, but by no means the majority, in the Eastern Province, and one or two elsewhere.

The temperature and humidity figures do not call for any special comment. The chief variations were in the north, where temperature was above normal, and humidity below it.

The amount of cloud was distinctly in excess at most stations.

Despite the eccentricities of the 23rd to 29th the mean air pressure was not far from normal and at the stations where wind was recorded velocities are about equally distributed above and below the average.

A. J. BAMFORD,
Supdt. Observatory.

I. B.
B.

THE DEPARTMENT OF AGRICULTURE EXHIBIT AT GALLE AGRICULTURAL SHOW.